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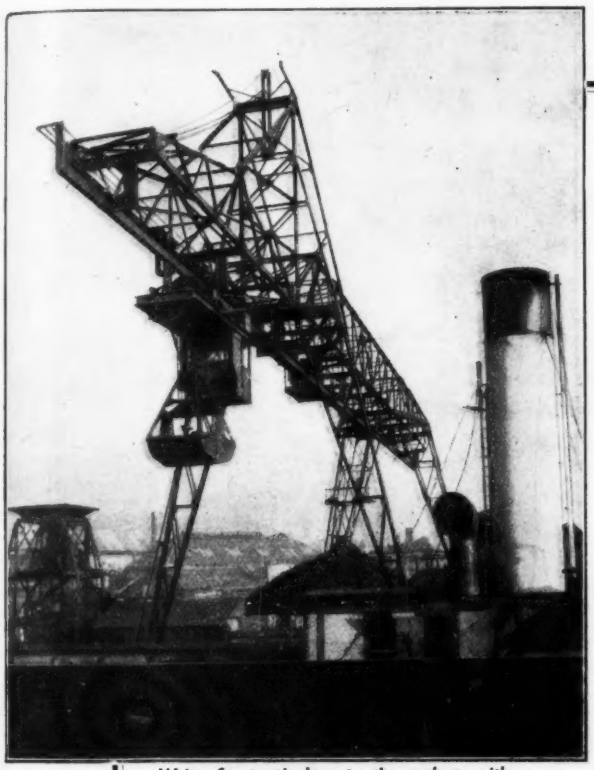

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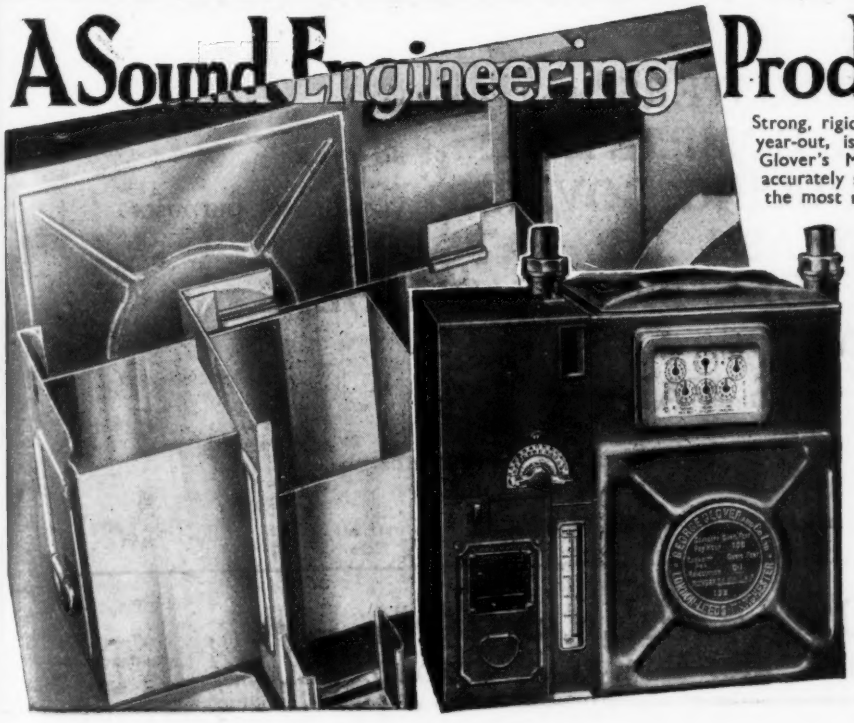

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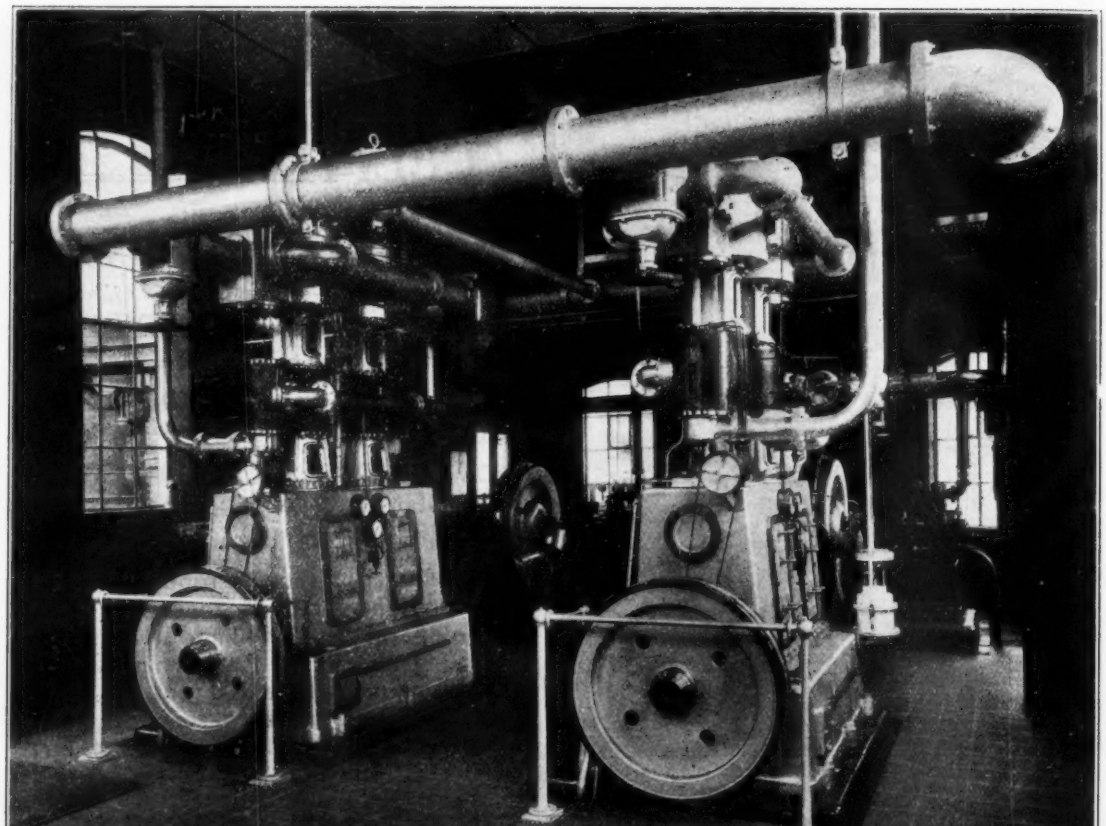

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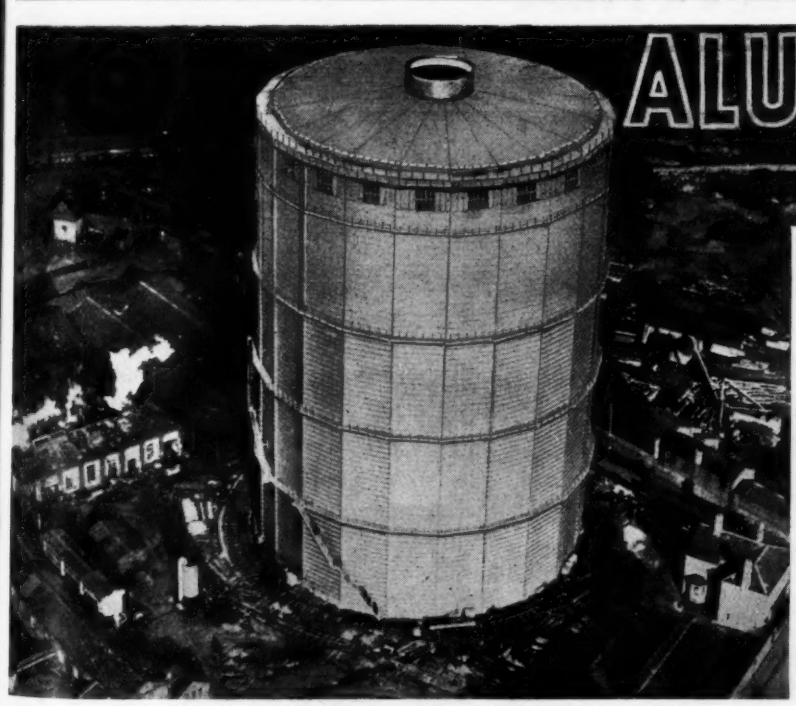

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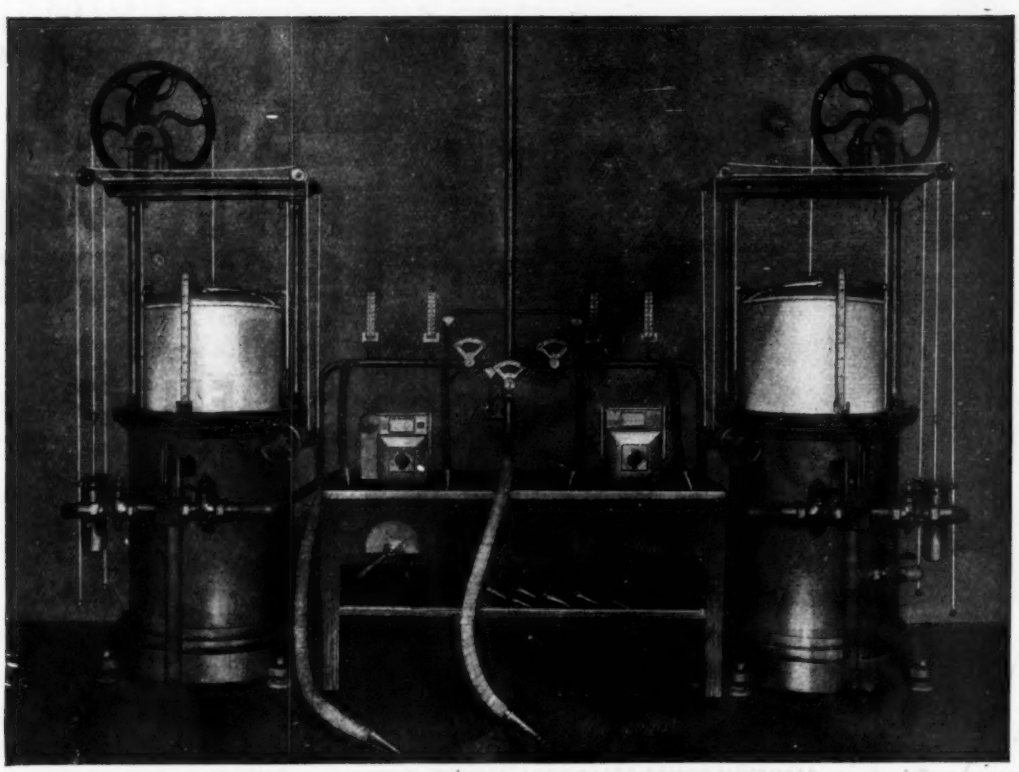

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NOVEMBER 13, 1935

Vol. 212. 87th Year No. 3782

Editorial Notes

The Autumn Research Meeting

That the Seventh Autumn Research Meeting of The Institution of Gas Engineers held in London last week was highly successful will, we are sure, be generally agreed. Attendances were good throughout the meeting, and the business was carried through very ably indeed by the President, Colonel Carr, whose enthusiasm is contagious. The programme was full and varied, and the communications presented of a standard of which the Institution and the Gas Industry as a whole may well be proud. The meeting was indeed a record of a year's research work efficiently carried out with keenness and ability; and there must be many another industry envious of our Industry's research achievements and organization. Which in no way implies that we should rest satisfied. There is need for a much larger measure of research on the utilization of gas—a need which was singularly well emphasized by the investigation reported to the meeting by Dr. Millett and Professor Cobb as the Gas Fellowship Report. Introducing this, Professor Cobb observed that when the investigation was commenced at the University of Leeds it was not even suggested that it should come within the orbit of the research work of the Institution. Nowadays, having regard to the importance of the industrial use of gas for metal heating, no one would question the legitimate position of the Report in the Proceedings of the Institution. "It is a sign of the times," said Professor Cobb. We ask for many more of these signs.

Research on the problems of utilizing gas becomes of greater and greater importance, and it is very proper that research into furnace atmospheres is to be continued in collaboration with the Iron and Steel Institute. The President put forward the view that, in addition, the subject of heat transference at comparatively low temperatures—something less than 500° or 600° C.—might well be investigated in view of the great possibilities for the extension of our business in low-temperature industrial work. Research on these and other problems of utilization will pave the way towards making possibilities into probabilities, but realities will in the end be achieved only if the sales personnel is properly equipped to put the probabilities across. And in this connection a feature accurately described by Sir Francis Goodenough as "deplorable" is brought out in the Report of the Gas Education Committee. This is the lack of candidates for the Diploma in Gas Engineering (Supply). It is lamentable that, of all the students who have taken 1st Class Higher Grade Certificates in Gas Supply, in all no fewer than 113, only two have gone forward to take the Diploma. It shows that administrators and managers of gas undertakings do not yet realize that gas is made to be sold. It shows a lack of discernment and encouragement which quite definitely is retarding business. The gas supply man of to-day needs to be, in his own line, every bit as well trained as the man on the manufacturing side; he ought to be no whit behind in his qualifications, remuneration, and status in the Industry. The sooner this is appreciated the better it will be for our progress.

"Status"

On this question of "status" we call special attention to the remarks of Colonel Carr regarding membership of The Institution of Gas Engineers. For some time now there has been much sore feeling on this matter. It will be recalled that Dr. Harold Hartley, of Radiation Limited, discussing at the Institution Meeting last June the Lacey-Masterman scheme of appliance testing and gas utilization research, expressed the opinion that the Institution shows scant appreciation of the scientifically trained men in its service, that there is too much moonshine about professional merit, and that eminent scientific men will not consent to serve on Institution panels, and the like, on an "unequal footing." He asked, for example, how the technical staffs of firms engaged in the manufacture of gas making plant or gas consuming appliances can be expected to co-operate fully unless they are put on an equal footing with others in the Industry. It is obvious, said Mr. Stephen Lacey, Senior Vice-President of the Institution, at the Research Luncheon on Tuesday of last week, that the Institution will rely more and more on the work of physicists and chemists; and he expressed regret that many of those serving on technical sub-committees, and of those who contributed Papers and opened discussions, are ineligible for membership of the Institution.

Which brings us to Colonel Carr's encouraging observations on this question at the Research Meeting on the Tuesday afternoon. The Executive Committee of the Council, he said, appreciates that there are many technical workers to-day who are contributing to the work of the Institution and would be most desirable members, but owing to the exact wording of the present Constitution they are not eligible for membership; and he explained that the Committee is applying itself to the consideration of minor revisions which would allow not only technical workers in gas-works, but others engaged in the carbonizing industry, to become members. Recom-

mendations of the Committee are under consideration by the Council, and it is hoped that the other Chartered Institutions—the Institution of Civil Engineers in the main—will not take exception to the desire to include as gas engineers those fuel technologists who are directly concerned in the work of the Industry. We look forward to the fulfilment of this reasonable aim.

In regard to the discussions at the meeting, these were helpful and satisfactory with the exception of the general discussion on the 1st Report of the Research Executive Committee and on gas research and investigation, from which we had anticipated much. In view of all that has been said in private conversation concerning the way in which research is organized by the Institution, it was disappointing that Mr. Tarratt's appeal for constructive criticism met with such cool response—we have, of course, mentioned the suggestions of Colonel Carr on gas utilization research—and we regretted the absence, through illness, of Dr. E. W. Smith, who would doubtless have set the ball of controversy in motion. As we have said, however, the " particular " discussions were helpful, though we share the regret of Dr. Hartley that no discussion was arranged to take place on the communication by Mr. Masterman and his colleagues on the subject of air vitiation and gas appliances, which would surely have added emphasis to the desirability of removing as far as possible sulphur compounds from town gas. On no previous occasion, however, have we found more appreciation of the Reports presented—one and all—and it is all to the good that research in the Gas Industry is quite definitely a popular line.

On later pages will be found our " Review," which is a short story of the meeting as a whole, while abstracts of the contributions and a full report of the discussions follow our nutshell account in this Institution Number.

Thirty Years

THOUGHTS on the thirtieth birthday meeting of the Society of British Gas Industries, reported in full in this issue, lead one to think that perhaps the Society's greatest failing has been excess of modesty. A moment's contemplation of the record of its services to the Industry recited—still with a maximum of modesty—by the Chairman at the General Meeting can only bring conviction of the wisdom of having formed the British Gas Federation even if only for the purpose of co-opting to the full the potential influence of the S.B.G.I. Thirty years do not seem long as time goes, and yet the Society is second in antiquity among the National Bodies only to the Institution. Through all the difficulties which must be inherent in co-ordinating to the common good the efforts of a number of members who are in keen commercial competition with one another, the Society, after 30 years, undoubtedly stands higher than ever before in strength, in prestige, and in usefulness to the Industry. But it is equally clear that at the present time it is still moving rapidly to higher peaks on the momentum of its own enthusiasm, of the increased recognition given to it through the B.G.F., and of its own serious acceptance of the responsibilities which this entails.

The membership figures are eloquent of the upward trend, and it can be taken for granted that they will continue upwards for some time to come until only some very special reason particular to itself will keep an eligible firm from seeking membership. And in this connection we would call attention to a point of interest which is perhaps not universally recognized in the Industry. The Chairman, Mr. D. M. Henshaw, in his remarks to the meeting, explained that they had, as a Council, tried to confine membership to firms of standing and repute, in protection of the good name and reputation of the Society. Which means that, while non-membership does not of course necessarily imply any stigma (instances known to everybody bear this out), yet membership does convey a standing for all to see. Which reminds one of the appeal to members of the Society by Mr. Valon Bennett, when he was President of the Institution earlier this year, to display the badge on notepaper and in advertisements for the guidance of buyers. Response to this appeal, which Mr. Henshaw repeated at the meeting, is being made by members, but the slowness in adopting it generally is difficult to understand.

The gathering was, as Mr. Henshaw described it, a very happy family birthday party, and it was a great thought, in the enforced absence of the President, Sir John Cadman, to invite Mr. Charles Clare, Founder and first Chairman of the Society, to preside. The " JOURNAL " has always naturally been proud of the part it was privileged to play in the formation of the Society, to which Mr. Clare so graciously referred, and it is more proud than ever to-day when the Society is showing greater virility than ever before after 30 years' existence.

Industrial Gas

MR. D. M. HENSHAW'S Address as Chairman was a statesmanlike review of the progress of the Gas Industry during the life of the Society, tracing the effect of specialization and co-operation between gas engineer and plant and appliance maker in the transition from a gas lighting industry to the present day of the large gas-making units which, as Mr. Henshaw suggests, have outgrown the term " gas-works." It certainly does create difficulties for us that gas-works have existed since the days when wax-works were fashionable, and we have urged more than once in these notes that the Industry is, in our opinion, apt to overdo the antiquity and long-service stuff, together with the aspirin tablets and disinfectants, while the electricity industry shouts new life and hope to the jaded populace. Mr. Henshaw lays emphasis on the importance of never ceasing to remind the public that the Industry is progressive in all its branches, and suggests that the appearance and construction of our modern works make more appropriate the term " gas power station." Now, which enterprising undertaking will be the first to seize the opportunity, when constructional alterations are in hand, of announcing that " the gas power station will shortly be opened for inspection by the public?" The effect might be astonishing.

If there is one feature of our business which Mr. Henshaw appeared to emphasize more than another, it is the industrial field. His reference to the Society's confidence that the Industrial Centres scheme " will prove to be an outstanding and successful example of specialization and co-operation between the manufacturers and the supply side of the Industry " will be specially welcome.

The direct interest of the Society in this very important branch is bound in time to bring it an accession of strength. The development of the industrial gas load has been rapid, and there are a large number of firms well established in other branches of industry who are obtaining, through what is comparatively a new development, a stake in the fortunes of the Gas Industry. There can be little doubt that many of them will appreciate the status within the Industry which membership of the S.B.G.I. confers, and the enthusiasm shown by Mr. Henshaw's Address for the continued progress of the controlled-heat-on-tap load can leave them little doubt of the advantages they will gain quite apart from the question of status.

In conclusion, let us wish every success through the next 30 years to the Society, which represents that very necessary unit in our national organization—a body which can speak with one voice for the contracting and appliance making side of our Industry.

Coal

We are not concerned in the "Journal" with politics, and there are certain aspects, therefore, of the acute present-day coal question which we do not propose to discuss. With the rest of the nation, we are utterly weary of the endless strife and discord which have torn the coal industry ever since the War, and we are in agreement generally with the popular verdict that, even granting the difficulties it has had to face, it has made an extraordinarily poor job of managing its own affairs.

It is fairly clear at this stage that public opinion, which in the end is generally a pretty good judge in this country of ours, has voted the miners an increase in wages, and it is equally clear that in present conditions the money is not there to pay an increase. Once again, therefore, a feverish last minute search is being made for ways and means of marketing coal to better advantage. Searches of this kind in the coal industry always are feverish and last minute, though it has been clear enough ever since the quota schemes were instituted after the disastrous stoppage of 1926 that they were not likely to prove effective, and there seems even less excuse than usual for feverishness in the present instance. In any case, coal selling agencies are now the talk of the day upon which the nation bases any hope of averting another disaster, and, though details are not yet known, we may be sure that public utilities will loom large in any scheme of "paying up."

It is interesting in this connection to recall that early this year Colonel Carr gave a lead to public utilities by voicing what is very generally, even if not universally, felt in the Gas Industry on this matter. He gave it as his view that the Industry is quite prepared to pay more for its coal provided that other competitive industries are asked to pay more for theirs in the same ratio. In considering this, of course, regard must be paid to the price at which the coalowners are able to charge up coal to their own gas-works—the coke ovens. And, on the occasion when Colonel Carr originally explained the position, he made it clear that we should welcome an assurance that it would be the miner who would first derive benefit from any increased price.

At the Research Luncheon of the Institution last week, Colonel Carr spoke in much the same sense, having in the meantime become President of the Institution, and having presumably had ample opportunity since his first pronouncement of confirming that it does indeed represent general opinion.

A Question of "Fair"

It should, therefore, be quite well known where the Gas Industry stands in this matter, and it is consequently disagreeable in the same connection to meet still another instance of failure to recognize the service of gas to the nation, and the extreme importance of it at the present juncture. Speaking recently in his Division (an electioneering speech, we grant) Mr. Ramsay MacDonald is reported to have said that "in the gas-works there had been certain discoveries in recent years which enabled coal used in the production of gas to be appreciably more productive than it used to be, and yet that coal, instead of being sold at a more economic price, was sold cheaper with its extended value than the price it was sold for without that extended value. I do not think it is fair. I think it is possible to get that further wealth in the coal transferred into the resources to which the miner can go for an increase in his wages."

Two men buy exactly similar Sunday joints. One uses it all—fat and lean—makes soup from the bone, and then grinds the bone for fertilizer for his backyard garden patch. The other (obviously too well off to be a gas engineer) cuts out a nice lean section and dustbins the rest. Would any politician venture to argue that it is *unfair* not to charge the careful man a higher price for his joint?

The Gas Industry has made its position clear on coal prices, but for goodness sake let us have any increases put on a higher plane than this. To regard them as a penalty for having been "unfair" enough to improve enormously the economics of coal utilization is hardly good enough. If this is the light in which we are to be represented to the public in connection with the present coal crisis, it is time we asked with "one big voice" who has carried out and paid for the research which has achieved results so desirable from the national wealth standpoint and what part the coal industry itself has played in it?

Preparing for Dearer Coal

While, therefore, our National Bodies will have to be extremely vigilant in coming months to see that our case is put to the public in a proper light, it behoves us to look round internally and make every possible provision to meet the increasing prices of raw material which appear inevitable. Fortunately the freedom gained from our last Act does not leave as our only available resource an ugly increase in flat rates of charge, and those who at present have promotional tariff schemes only in contemplation will no doubt hasten to get them beyond this stage. We think others who have not arrived even at the contemplation stage will do well to put in some quick thinking.

Another matter which can help enormously, and in which we hope rapid progress may be made, is in extended organization of coke marketing. The last few weeks, as has been reflected in our columns, have been buzzing with coke talk. The Coke Oven Managers' Association held their Annual Meeting, lamented their lack of sales organization, and pronounced that the coking industry should look upon gas undertakings not as competitors but as friends; that the relations need not stop at selling gas to the gas undertakings, but might easily be extended to making reciprocal arrangements with regard to selling coke.

Colonel Carr hastened on the the same occasion to extend the Gas Industry's hand of friendship and offer of co-operation, and then followed, a few days later, the Annual Meeting of the London and Counties Coke Association, at which was made a revelation of the remarkable results achieved in so comparatively short a time by that organization. At the same time the view was expressed of Sir David Milne-Watson, and others who have had the experience of bringing the Association to its present state of efficiency, that any attempt to extend its activities to cover the whole country would be inadvisable, but that the experience is freely at the disposal of others who may aim at the formation of similar bodies.

This short recapitulation of points which have been fully discussed in our columns in recent weeks leads back again to the increased coal price question. As Colonel Carr rightly maintained at the Research Luncheon, if the Gas Industry is to pay more for coal, it must seek to enhance the value of its coke, and it would be more desirable than ever to protect the position as had been done in the London area. It therefore behoves all concerned to take a broad view and find ways and means of working in conjunction with the coking industry in this matter.

We are not going to belittle the difficulty of finding these ways and means, but we do suggest that the coke oven interests are probably in the mood at present to be more receptive of suggestion than ever before. The colliery owners, who generally speaking are the coke oven owners, are faced with the absolute necessity of increas-

ing revenue. They are thinking hard in terms of coal marketing schemes, to which surely the natural corollary is coke marketing. But the Gas Industry is far better organized, and in much calmer waters, to work out details of co-ordination, and, moreover, it has the London and Counties' experience freely placed at its disposal. In any case, whether the initiative is to come from the District Associations or some other direction, now is the time to organize—if possible with a view to subsequent co-operation with the coke oven interests; if not, then at least as the best possible means of resisting their competition.

The B.R.T.A. Year

With thoughts of the coal industry's troubles still in mind, we could point to yet another direction in which the public can help the coal industry through the coal utilization industries. It can demand, and insist on having, British roads made with British tar in all circumstances. Discussing not long ago some sweeping claims which had been made in a leading national daily for asphalt road construction in connection with the issue of a new standard specification, we stated that the new asphalt road may be cheap, but the tar-macadam road is cheaper, and it is a British, not an imported, article. As to safety, the tar-macadam road, by its very construction, is far superior to an asphalt road.

We stand by these assertions, and they are fully supported by Sir David Milne-Watson's speech last week as President of the British Road Tar Association. As yet another means of extracting the utmost value from British coal, and so helping the coal industry, too big an effort cannot be made to ensure that as large a proportion as possible of the big road expenditure of the next few years is allocated to British tar. We recollect that the whole labour movement pledged itself not long ago to support of the miners' claim for increased wages. Here, then, is a direction in which it would seem that a very useful form of support could well be turned, with the considerable influence which labour has in local Government. Though why influence should be needed at all on behalf of British tar for British roads is difficult to imagine.

The year's record of the Association is a tale of continual progress in all directions, including an increased membership. Sir David, in his Address, expressed the hope that the day may not be far distant when every producer and distiller of tar will be a member, to join in the good work of impressing on all consumers of tar the knowledge that the tar industry is giving them a product which is the result of both collective and individual experience. A 100% membership would seem to us very much in the interests of all concerned.

Four Thousand B.Th.U.

All has been quiet on the " gas unit " front for some little time. The unit is one of those matters upon which the Gas Industry finds it difficult to make up its mind, firstly, as to whether it wants a unit at all, and, secondly, if so, what that unit should be. In the upshot, apart from spasmodic discussions of the subject and news from time to time that another gas undertaking has decided on the adoption of one unit or another, nothing gets done on any considerable scale.

Interest, however, will doubtless be revived by a recent announcement to its consumers by the South Metropolitan Gas Company that it is adopting a gas unit. " In future," states an explanatory leaflet, " while the total charge will be shown in therms, each gas account will also show the number of ' gas units ' used since the last reading of the meter. It will be observed that no change is made in the price of gas or in the method of charge. Gas accounts will not be affected in any way, except that they will now provide what, it is hoped, will be an additional and informative guide to the value of the services for which the consumer is asked to pay."

The South Metropolitan Gas Company, while always pursuing the paths of progress on both the technical and the commercial sides, is not an undertaking which lightly embarks on schemes of any kind without the fullest consideration; in fact, it has a reputation second to none for what may be described as " steadiness." In the absence, therefore, of any recent lead on the subject of the gas unit by the National Bodies, we believe that Dr. Carpenter's move in the matter is of considerable importance, and that it will be welcomed in many quarters as a very authoritative pronouncement in favour of the adoption of a unit for the convenience of consumers and to facilitate comparison with the cost of other forms of fuel and energy. We refer readers to later pages of this issue for the full text of the Company's explanatory leaflet.

The relative merits of units of 4,000 or 3,412 B.Th.U. have been discussed many times in the past, but, as we pointed out when last commenting on the subject earlier this year, the odds have been running heavily in favour of 4,000. This, of course, was the size which the National Gas Council Committee on Charges, in conjunction with the Institution, decided as long ago as 1931 would be more suitable, and which has been adopted in recent times by several progressive gas undertakings. It is, therefore, a matter of the greatest interest that Dr. Carpenter has decided on 4,000 B.Th.U. as his sub-division of the therm, and this decision must of course be regarded as authoritative, adding great weight to the argument of those who advocate this size for the gas unit. We still consider that gas at " only just a little more than a third of a penny a unit " sounds most attractive, with no standing charge, and we hope that the South Metropolitan Gas Company move will stimulate fresh interest in the question of the gas unit. Anything which is likely in any circumstances to help us to sell gas must be kept constantly in the forefront.

Learning in Comfort

It is unusual for *The Times* to publish on its leader page what appears to us an article smacking heavily of propaganda. The unusual occurred, however, in the issue for Nov. 2, and it is an article which may perhaps give a wrong impression of the great love which the modern undergraduate at Oxford has for electricity and how this love is shared by the authorities. We pass by as legitimate game the fact that the author of the article has a dig at Cambridge for preferring other methods of ensuring comfort.

The impression we gained from the article is that, with the exception of American Rhodes Scholars, the Oxford undergraduate has in effect become a publicity agent for electricity, which has transformed previously barbarous conditions into an Elysium of Learning. We are not questioning the figures showing the increase in the use of electricity by Oxford undergraduates and Oxford dons since 1932 as the result of a two-part tariff with low commodity cost, though we do question whether the healthy undergrad of to-day does disregard a chimney flue as a means of efficient ventilation, and whether he really is so excited about electrical heating and water heating. Questions of pints of beer apart, is the room of the electrically-minded undergrad so very much more hospitable than that of the undergrad who finds the gas fire a source of cheery warmth?

" Nothing is to be gained," observes the writer of the article, " by extravagant claims for electricity "—with which, of course, we agree. But we assume that he does

think that something is to be gained by ignoring the services rendered to learning by the Gas Industry. Things were not quite so black prior to the increased use of electricity by Oxford Colleges since the Corporation took over the supply and introduced the two-part tariff in 1932. There is another side to the "New Amenities at Oxford"—the title of the article in *The Times*. The facts are that since 1932 the gas consumption of Oxford Colleges has grown from 44,766,100 million cu.ft. to 50,184,900—a matter of over 12%, while, though gas is used to some extent for water heating, this service is in the main carried out by coke-fired boilers. And gas is used for cooking purposes in all colleges except one. Credit for the increased comfort of the Oxford undergraduate cannot be given wholly to electricity. In regard to methods of charge, we may mention that the Oxford and District Gas Company introduced an attractive two-part tariff for gas early in 1933.

Personal

R. W. Hunter.

In succession to Mr. Thomas Hardie, who, as was announced in last week's "JOURNAL," has been elected to the Court of Directors, Mr. R. W. Hunter has been appointed Chief Engineer to the Gas Light and Coke Company.

Mr. Hunter stated in a recent interview that Beckton had doubled in capacity and had been almost completely mechanized since he had known the Station. It was now sending out up to 5 million cu.ft. an hour and had produced as much as 106 million cu.ft. in a day. Even this did not extend Beckton to the full, for the Station had a total capacity of 120 million cu.ft. a day.

Mr. R. W. HUNTER.

Four developments affecting the practice of gas engineering that had taken place in his professional experience seemed of especial interest. First, while horizontal retorts were not changed in principle, the details of their construction and the efficiency of their operation had been so improved that they could still hold their own with more recent systems. The coke ovens at Beckton had proved equal in performance to any other type of carbonizing plant. Secondly, power costs had been enormously reduced at Beckton by the introduction of waste-heat boilers and modern high-speed condensing turbines. Thirdly, important economies in the maintenance and efficiency of the mechanical equipment had been effected by the establishment of a large-scale machine shop. Fourthly, he was struck—as all engineers must have been—by the spread of mechanical handling of material. Beckton now handles 2 million tons of coal annually (for its own use and for transfer to other stations) and holds up to 270,000 tons in stock. For dealing with this and other materials in proportionate quantities there were, in addition to the extensive works railways, large installations of belt conveyors. This was a striking contrast to the Beckton he first knew more than thirty years back.

Mr. R. W. Hunter was educated in Chester, commencing his career in 1897 as pupil of his father, the late Robert Hunter, Engineer and Manager of the Chester United Gas Company, and of his successor, Mr. J. C. Belton. He studied chemistry and mechanical engineering, &c., at the Chester Technical School, and later, at the Polytechnic, London. He took 1st Class Honours (City and Guilds Institute) in gas manufacture in 1904. In 1902 he entered the service of the Gas Light and Coke Company at their Kensal Green Works, and was transferred to Beckton in 1903, where he was a Senior Assistant Engineer in charge of a section of that Works on the outbreak of war. Mr. Hunter held a commission in the 12th London Regiment "Rangers" (which is mainly composed of Gas Light and Coke Company personnel, with the Governor of the Company as Hon. Colonel), and proceeded to France with the 1st Battalion in 1914. After serving throughout the war until invalided out in 1918, he returned to Beckton, where he has since remained, with the exception of a period of two years as Deputy Engineer at Bromley-by-Bow. After a period as Senior Officer in charge of the Works during the serious illness of Mr. W. B. Leech, on the transfer of the latter to the Chief Office of the Company, Mr. Hunter was appointed Station Engineer at Beckton in 1928. He joined the old Gas Institute as an Associate Member in 1900, and is now a member of The Institution of Gas Engineers, of the Institute of Fuel, and of the Southern Association of Gas Engineers and Managers.

Mr. Hunter won the H. E. Jones London Medal in 1933 for a Paper on the Beckton Coke Oven Plant, read at the Liverpool meeting of The Institution of Gas Engineers.

* * *

Mr. M. DARLING, Cowdenbeath, has been appointed Distribution Superintendent with Armadale Gas Company, Ltd. Mr. Darling has held a similar position with Cowdenbeath Gas Company for the past fifteen years.

* * *

We learn that Mr. W. WILSON, of the Imperial Continental Gas Association at Antwerp, who is a son of the late Robert W. Wilson, has had conferred on him by His Majesty the King of the Belgians the Decoration Industrielle de Première Classe in consideration of his thirty years' uninterrupted service in the Gas Industry. His Majesty King George has graciously permitted Mr. Wilson to accept and wear this decoration.

* * *

The Glasgow Corporation Gas Committee has recommended the appointment of Mr. JAMES HALL, Assistant Station Manager at Provan Gas-Works, as Assistant Station Manager at Dawsholm Gas-Works.

Obituary

The death occurred on Nov. 7 at the age of 63, of Mr. WALTER BOWDEN, J.P., of Hayfield, Chairman of Directors of the Hayfield Gas Company.

* * *

Mr. WILLIAM GILLMAN, J.P., who had been a Director of the Portsmouth Gas Company since December, 1914, died at Southsea, on Nov. 11, at the age of 83. Mr. Gillman, a retired banker, became Deputy Chairman of the Company in July, 1919, a position he only relinquished a month ago, although he retained his seat on the Board. He was Portsmouth's second senior magistrate, having been appointed a Justice of the Peace in December, 1900.

* * *

We regret to announce the death in her 83rd year of Mrs. R. MITCHELL, widow of the late R. Mitchell, formerly Engineer and Manager of the Edinburgh Gas Light Company (then known as the Edinburgh and Leith Gas Commissioners) for over sixteen years and father of two well known members of the Gas Industry, Mr. G. P. Mitchell, of the Worcester New Gas Light Company, and Mr. J. Mitchell, of the Leicester Corporation Gas Department.

News, S.B.G.I. Annual Meeting, and other items follow our report of the Institution Research Meeting, see page 514 *et seq.*

THE "JOURNAL" REVIEW

OF THE

Institution Research Meeting

Nov. 5 and 6, 1935

There was an excellent attendance when Colonel W. Moncrieff Carr, O.B.E., President of The Institution of Gas Engineers, took the Chair at the Seventh Autumn Research Meeting of the Institution on the morning of Tuesday, Nov. 5. The Meeting was held at the Institution of Mechanical Engineers, London.

A Lamentable Lack.

Following the formal opening of the meeting, Sir Francis Goodenough, as Chairman of the Gas Education Committee, was called upon to introduce the Committee's Report for 1934-35. The Report shows that the number of examinees is maintained—actually increased, the Gas Supply examinees increasing from 223 in 1934 to 271 in 1935, which is highly satisfactory. What is not satisfactory, however, is the fact that once again there is an entire absence of Diplomas in Gas Supply. To date, no fewer than 113 students have taken First-Class Higher Grade Certificates in Gas Supply, and yet only two have gone forward to win the Diploma. Is it that the importance of highly qualified gas supply men in the Industry is not realized by the administrators and managers of gas undertakings? Sir Francis put forward the view that, in general, managers are not doing what they could to encourage students to obtain higher quaiifications on the Supply side, and observed that one reason for the lack of entries for the Diploma in Supply is that students regard with fear and trepidation the idea of having to present a thesis, which at present, of course, is one of the requirements for the gaining of a Diploma. The Committee is seriously disturbed about the whole matter, and proposes to take steps to remedy what is undoubtedly a sorry state of affairs.

The problem was further dealt with by the President in seconding the motion for the adoption of the Report. He pointed out that there are likely to be many more openings in our Industry in the future on the supply side than on the manufacturing side, and whatever the effects of the grouping of undertakings may be, it can never result in less demand for the highly trained and skilled technical man. Those responsible should let it be known that such openings exist, and should make it known too that the remuneration offered to the trained man on the supply side will not be lower than that offered to those on the manufacturing side.

In the course of the discussion, Mr. C. H. Creasey, who has rendered such valuable assistance in the development of the Education Scheme of the Institution, explained that there is evidence that men trained under the scheme in Manufacture were transferring to Supply. He also asked that careful consideration should be given to the plan of allowing students who have shown capability and displayed capacity in connection with the Ordinary Grade Certificate, time during the day to attend classes of instruction. Part-time instruction given wholly in the evening imposes a severe and unnecessary strain on the willing student. With which view Sir Francis Goodenough expressed himself in entire agreement.

The old question of external and internal students was raised once again by Mr. G. Dixon, who suggested that the Institution might consider the advisability of carrying out correspondence courses direct, with a view to reducing the cost of such courses to the student. Mr. Dixon also enquired whether it would be possible for the Education Committee to make some sort of a census of the number of potential students in isolated districts. To these suggestions Mr. John Terrace made spirited reply, as an "old war horse to an old war cry."

Colonel Carr said that the Committee might well consider the general policy of post-graduate courses of training to help those leaving the University and entering the Gas Industry on either the Manufacturing or the Supply side.

New Diplomés.

Then came the presentation of Diplomas, six in all, and, as mentioned, all in Manufacture. First-Class Diplomas were awarded to A. E. Haffner, of Ewell, and L. A. Ross, of Portsmouth; while F. Bell (Liverpool), A. Harrison (Great Harwood), W. J. Shelley (Hinckley), and C. R. E. Turner (Birmingham), gained Second-Class Diplomas.

This brought us to the formal presentation of the First Report of the Research Executive Committee, which was discussed at the final session on Wednesday afternoon.

Presenting the Report, Mr. Tarratt mentioned that the Duckham Research Award will be made this year, the Fund providing the handsome sum of £365 per annum, a lasting tribute to the memory of the late Sir Arthur Duckham and one taking a form which would have appealed to him greatly. It is the intention of the Committee to proceed with the abstracting of current gas literature and to prepare a summary of past research.

Among the subjects dealt with by the various technical committees are the presence of gum in gas, the reduction of organic sulphur compounds, and the process for the production of non-poisonous town gas.

Pipe Protection.

The next item was to receive the Report on Protective Coatings for Underground Pipes, by A. B. Densham and F. C. Smith. This Report, which describes work carried out in order to improve the methods of protecting underground pipes, was published in the "JOURNAL" for Sept. 11 last; in it, tests of the efficacy of various protective coatings are described. It is believed that the function of such a coating is to keep water permanently away from the pipe, so that the coating must be resistant to water penetration and to decay or mechanical damage. The electrical resistance test for water penetration is considered and reference is made to various mechanical tests. Some of the coatings investigated are discussed and it is concluded that pitch troughing or a pitch or bitumen coating reinforced with fabric gives the best protection; galvanizing or cement troughing is valuable in the absence of stray currents; bituminous paints or various bandages are not satisfactory. The relative merits of coal tar pitch and bitumen are discussed.

The results of field experiments over 2½ years indicate that there is no great difference between the external corrosion of wrought iron and steel. The value of the electrical resistance test is confirmed, and the order of merit of the different coatings investigated is given.

The theory of the measurement of the electrical resistances of pipe coatings is discussed and details are given of methods of testing coatings and of materials used. There is a short account of actual methods of applying coatings and burying coated materials. The Report concludes with a bibliography and numerous photographs of the test pipes.

In Critical Mood.

The Report was criticized by two speakers during the general discussion on research at the final session on Wednesday afternoon, and both speakers disagreed with the authors' findings in regard to protective bandages.

Dr. W. Beck, now Chief of the Department of Corrosion Research at the Institute for Physical Chemistry of the University of Warsaw—who, it will be remembered, gave a Paper to the Institution at the June Meeting in 1933—said that the authors' tests in this connection " cannot be considered as being of importance with reference to the corrosion of underground mains." The other speaker, Mr. H. M. Ridge, who has had a great deal to do with corrosion problems in various parts of the world as well as at home, also cannot see eye-to-eye with the authors and believes they will desire to revise their opinions. To these criticisms Mr. Densham made effective reply.

Products of Combustion.

The Report on Air Vitiation and Gas Appliances, by C. A. Masterman, E. W. B. Dunning, and A. B. Densham, was then received. This Report expands the scope of the previous Report upon Combustion Standards of Gas Appliances, presented to the Institution by the first two authors in 1931. It reviews in a more general way the possible causes of air vitiation due to Gas Appliances and the possible nuisance from smell, expands the work on possible hazard to health, and refers the whole to practical conditions in occupied rooms.

The smell of excessive concentration of products of combustion is attributed to sulphur oxides, for which a permissible limit of 0·0001% is derived. The maximum imperceptible concentration of products, therefore, depends directly upon, *inter alia*, the sulphur content of the original gas.

The effect of air vitiation upon combustion is referred to, and a number of characteristic curves is given showing how different gas appliances are affected as vitiation increases. Provided the appliances are not themselves defective or operated at an excessive gas rate, combustion remains unprejudiced in all cases up to a vitiation corresponding to more than 1% carbon dioxide, and in many cases to limits far beyond those at which matches, &c., can be burned.

As a result of previous work and further tests reported, a generalization is attempted on the degree of ventilation to be expected in normal occupied rooms. A number of practical conditions greatly influence the results, but an air change of less than one per hour is found to be unusual. A more normal figure, with windows shut and no flue operating, is about two air changes per hour.

Conclusions are summarized showing the limiting gas rate for continuously or intermittently operated appliances without flues up to which limit no nuisance (or hazard to health) will result.

Resulting conditions may depend upon such factors as the degree of absorption of sulphur oxides by the walls of the room and by the relative proportions of sulphur dioxide and trioxide. Broadly speaking, however, for a gas containing 20 grains of sulphur per 100 cu.ft., the maximum imperceptible gas rate for continuously burning flueless appliances is about 12 cu.ft. of gas per hour per 1,000 cu.ft. of room capacity, with an air change of two per hour. Where, as may be more frequent, the appliances are operating intermittently, similar limiting conditions are consistent with higher gas rate amounting, for example, to 30 cu.ft. per hour per 1,000 cu.ft. of room capacity for appliances operating for 15 minutes only at a time (intermediate stand-by period not less than 1 hour). These limits depend upon perceptibility of sulphur oxides and will be proportionately increased or decreased according to the sulphur content of the gas. Disregard of these limits may lead to discomfort due to pungent smell or, in the case of heating appliances, to overheating, but will not inevitably involve danger to the occupants of the room. Possibility of danger or hazard to health appears able to arise only if there is gas leakage or bad combustion in the appliance, both of which possibilities can and must be prevented, whatever be the circumstances of use of the appliance.

It is shown that although by the injudicious use of flueless gas appliances a nuisance due to the smell of products of combustion can be created, this nuisance is readily avoidable by consideration of the room capacity and degree of ventilation outlined in the Report.

Strengthened International Contacts.

The President then called upon Mr. Thomas Hardie to present the 36th Report of the Joint Research Committee of the Institution and Leeds University, and in doing so expressed the Institution's appreciation of the excellent work which Mr. Hardie has done as Chairman of this Committee over a number of years. He also expressed the Institution's pride and pleasure in the fact that Mr. Hardie has been elected to the Court of Directors of the Gas Light and Coke Company. Colonel Carr added that during the year we have strengthened our contacts with the gas industries throughout the world through the medium of the International Gas Union and the International Commission on Illumination. At the meetings with these bodies liaison was established with the principal Continental Associations, and it is hoped that it may be possible to set up a permanent exchange of information between the Institution and the Associations of other countries. " It would," the President said, " be impossible to over-estimate the importance of these international meetings of highly qualified technical men from every civilized country in the world. They point the way, I believe, to a new world order. In these days, when mechanical progress is moulding the nations of the world into a single economic unit, it becomes more certain that co-operation between the technicians of all countries is the surest way of preserving peace. I rejoice to think that our Industry should lead the way in establishing co-operation between the technical men of the gas industries in this and other countries."

Mr. Thomas Hardie, returning thanks, said that his work on the Committee had proved thoroughly enjoyable, and he trusted that the new Chairman, Mr. E. V. Evans, would be accorded such excellent support as he himself had received.

Corrosion from Sulphur Oxides.

The 36th Report of the Committee contains an account of the continued investigation of the action of the products of combustion of town gas upon typical metals used in the construction of gas appliances and more especially the effects of burning gas with a lower sulphur content than is at present common in town gas.

Experiments are described in which a number of metal tubes have been simultaneously subjected to the continuous action of products of combustion under strictly comparable conditions for a period of six weeks, using gas with a sulphur content of 8 grains per 100 cu.ft. The experimental tubes were made from sheet metals, and were surrounded by water-jackets maintained at 40-60° F. whereby some 94% of the water produced by the combustion of the gas was condensed on the inner surface of the tubes. The gas used was town gas from which the sulphur compounds had been almost completely removed, and to which carbon bisulphide was then added to give the desired sulphur content. The course of the corrosion was followed by the collection in 3-day batches of the condensates, in which the contents of metal, sulphur acids, and nitrogen acids were determined. There was a tendency for the condensates to throw down precipitates and appreciable deposits formed on the walls of the tubes in some cases.

When the metals are arranged in order of resistance to corrosion, their sequence is substantially the same as that previously observed when burning gases containing 25 and 50 grains of sulphur per 100 cu.ft. Lead, tin, and solder show a marked superiority over the remaining metals throughout; as the sulphur content of the gas is reduced, however, the difference between the metals exhibiting medium resistance and those showing the least resistance to attack becomes less pronounced.

The rate of corrosion falls as the sulphur content of the gas is reduced, but the fall is appreciably less than would be expected from the assumption that corrosion is proportional to the sulphur content of the gas. Nor is there evidence of any sudden drop in corrosion when the sulphur is reduced below a certain value, but rather an indication that corrosion will still occur even if sulphur is completely removed. The nitric acid found in the condensates becomes relatively more important as the sulphur content of the gas is reduced, and would itself account for corrosion occurring even with a completely sulphur-free gas.

The Report shows that a considerable reduction of corrosion troubles could be effected by reduction of the sulphur content, and such a course would have other advantages. The experiments indicate, however, that the complete removal of sulphur from town gas would not completely eliminate corrosion.

Importance of Eliminating Sulphur.

The speakers in the discussion were Mr. Masterman and Dr. Harold Hartley, of Radiation Limited, and the points they raised had close similarity. Mr. Masterman emphasized that the importance of sulphur compounds in gas is two-fold. First, it is their perceptibility in the diluted products of combustion which fixes a limit to the size of flueless heater which can be satisfactorily used in any given circumstances. Where the sulphur content of the gas is high it may even be undesirable for this reason to fix a flueless heater of sufficient size to give adequate warmth to the room where the room is ill-ventilated. Where the sulphur content is high the undertaking must either itself discourage the business in certain directions

or must risk losing the goodwill of the consumer and so see business lost. In regard to the conclusions given in the Report concerning the resistance of different metals to corrosive attack, both Mr. Masterman and Dr. Hartley pointed to the difference between the practical conditions under which appliances are used, and the conditions under which the laboratory investigation was conducted at Leeds. In the tests carried out at Leeds condensation was almost complete and the results are judged chiefly by the amount of actual corrosion which has taken place. In practice, corrosion condensation is usually far from complete, and the need for maintenance arises not from the complete destruction of the appliances by corrosion but by reason of the corrosion deposits building up to such volume as to interfere with proper combustion and performance. Where corrosion, for instance, is taking place on an aluminium wall, the weight of the corrosion product may be very small indeed, but it may be extremely voluminous, and therefore prejudicial at an early stage to the satisfactory operation of the appliance. Dr. Hartley said that if for construction there are employed materials which it can be ensured will continue to resist the attack of products of combustion the cost of the appliances may be increased by as much as 30%—no light charge to be placed upon the consumer. The Report, he remarked, does emphasize the fact that the aim of the Industry should be the complete elimination of sulphur. In view of the importance of ventilating thoroughly the question of the effects of products of combustion, Dr. Hartley expressed regret that it had been decided to have no discussion on the important Report by Mr. Masterman and his colleagues on air vitiation and gas appliances.

Operation of Water Gas Plant.

The final item of Tuesday morning's session was the presentation and discussion of the 37th Report of the Joint Research Committee, which was introduced by Prof. Cobb and Dr. Dent. It constitutes a detailed and critical review of the tests described in the 35th Report, including general consideration of the water gas process, a basis for the operation of a water gas plant, and an account of practical measurements and observations required for the adjustment of the plant.

Presentation by Dr. F. J. Dent.

Introducing the Report, Dr. Dent explained that the discussion is centred upon the compromise which must be made between the reduction of capital and labour charges brought about by raising the output and the accompanying increase in the cost of raw materials and maintenance. In the Report, consideration is given to the variations of the charges for raw materials and maintenance. Thus, in obtaining a high output, wear and tear and clinker formation increase due to the high temperature required in the fuel bed for steam decomposition, the quality of the B.W.G. diminishes, and a smaller percentage of the steam is decomposed, as a result of the high rate of steam supply used, while the oil efficiency decreases due to the rapid rate of oil supply needed in carburetting the greater output of blue water gas to a given calorific value.

Whether or not the procedure is also accompanied by an increase of the coke consumption depends upon the method used to obtain the greater output. The coke consumption is not increased appreciably so long as the blast pressure can be raised, so that, with the temperatures in the fuel bed as high as clinker formation will permit, there is no excess of carbon monoxide in the blow gases above carburetting requirements.

A high blast pressure is, however, desirable in view of another consideration. By reducing the amount of heat lost as carbon monoxide in the blow gases leaving the generator, it increases the amount of heat stored in the fuel bed during the supply of a given volume of air. For this reason, and also due to the high rate of air supply obtained, the proportion of the time occupied by blowing is minimized and, with a longer time available for steaming and oil injection, either a higher output or improved decomposition of the steam and oil can be secured.

Broadly, the results of the present investigation indicate that the cost of water gas manufacture would be reduced if plants were operated at higher output. It appears that, in many cases, blast pressures could be increased with advantage, especially when using the denser fuels from chambers and horizontal retorts, and also that, in obtaining a high output, it is justifiable to allow the percentage of carbon dioxide in the gas to increase beyond the limits usually accepted. In this country, many of the fuels available have ashes of medium or low fusion point, but before this property of the fuel can be regarded as restricting operation, operating conditions must be such that no excess carbon monoxide is produced when the temperatures in the fuel bed are as high as clinker formation with these fuels will permit. In the tests made by the Joint Research Committee such has not been the case.

With regard to the percentage of carbon dioxide in the gas, distinction should be drawn between this constituent and other inerts such as nitrogen. While the presence of nitrogen in the gas bestows no benefit on the process and should be reduced as far as consistent with satisfactory purging, the permission of more carbon dioxide in the gas allows a greater rate of gas production to be obtained during the run period.

Effecting Economies.

While the compromise between the charges for capital, labour, raw materials, and maintenance has always to be made at the installation of plant and when existing plant is to be extended, capital charges do not enter into the daily operation of a plant which has adequate capacity to supply the gas demanded from it. In daily operation the question becomes, how to minimize the remaining charges. For such circumstances, the present investigation indicates that the most economical method of working is to modify operating conditions, when the demand for gas is low, in order to take advantage of the possibility of supplying steam and oil at slower rates and of using lower temperatures in the fuel bed. In the general case, when the aim is to secure the greatest economy in raw materials, the output of a plant should be reduced by shortening the blow period, retaining the same high blast pressure which is used for the full output. Such a procedure maintains high temperatures in the fuel bed and makes available the longest time for steaming and oil injection which is possible at a given output. On the other hand, when maintenance charges are an important item, for example, on hand-clinkered plants, reducing the output by lowering the blast pressure will enable the fuel bed to be operated at a lower temperature, while producing blow gases with sufficient heat for carburetting.

In view of such considerations the Report proposes that the operator of a water gas plant should standardize three or four cycles corresponding to different outputs. The cycles used should then be chosen according to the fluctuations in the demand for gas, particularly according to those seasonal fluctuations which can be forecast with some certainty. The observations to be made in regulating plant operation according to such a system are few, and experimental methods which have been used satisfactorily to obtain the data required are described in the appendices.

The Report also emphasizes the importance of using a deep fuel bed, operating the mechanical grate as slowly as clinker formation will permit, and securing complete admixture of the blow gas and secondary air at the top of the carburettor.

Tests on cokes of different grades showed that the performance of the plant was in all respects better when using coke of a normal grade (50% 3-2 in.) than with smaller grades. The loss of performance was not marked, however, until coke of less than 1 in. was used.

In discussing the tests the various factors investigated have been regarded primarily from the point of view of circumstances in which it is most economical to maintain the plant self-supporting in steam. These circumstances existed on the plant tested where, with the blast pressure available, avoiding an excess of carbon monoxide in the blow gases above that needed for carburetting required the temperature of the fuel bed to be limited, with consequent poorer steam decomposition. The conclusions reached will apply, however, to other circumstances in which excess carbon monoxide can be avoided through the blast pressure. Conditions in which the heat in the blow gases is controlled to either steam-raising or carburetting requirements are similar in that they both correspond to a definite proportion of the heat, liberated during the blow period, leaving in the blow gases.

Purging Losses.

The first speaker in the discussion was Dr. King, of the Fuel Research Board. Among the points he touched upon was, as he expressed it, the very real danger that on a short cycle of operation the thermal losses resulting from incomplete purging may exceed a reasonable figure. He mentioned some old experimental data which demonstrated a thermal loss of as much as 18% in this direction—a figure which Dr. Dent said in his reply greatly exceeds anything with which he has come into contact. There is, he said, no need to lose more than 1% of blue water gas by purging. Dr. King suggested that purging efficiency might be increased by applying some form of streamlining to certain portions of the plant. The importance of streamlining, observed Dr. Dent, had not occurred to him because he had not encountered the difficulty of loss through

purging. On the other hand, he has met with the difficulty of providing adequate mixing of the blue gas and secondary air on the water gas plants he has tested. Mixing of the secondary air is much more important than obtaining streamlining through the checker bricks. Useful contributions to the discussion were made by Dr. R. H. Griffith, of the Gas Light and Coke Company, and Mr. J. M. Webber, of Croydon. Dr. Griffith suggested that more attention might be given to the operation of ordinary down-run sets and that efforts should still be made to eliminate the annular boiler or at least to reduce it considerably in size. The elimination might be achieved either by cooling the generator walls with air or by supplying air to the fuel bed in such a way that excessive local heat is not developed and clinker formation is never allowed to occur. This can only be attained by some sub-division of the air supply to the fuel bed. Mr. Webber commented on the incidence of capital and labour charges on the operation of water gas plant, maintaining that the true cost of a process—the cost which affects the profit and loss account—is the total expenditure over, say, a year, and not the cost per therm or per ton. He went so far as to suggest that in considering how to operate the plant to the best advantage these charges should be entirely ignored. Bearing in mind the true function of a water gas plant, he is of opinion that only a practical trial of the methods indicated by Dr. Dent will show whether it is really going to pay to take full advantage of them.

Effluents and Ammonia.

Tuesday afternoon was devoted to the presentation and discussion of two Reports, the first being that of the Liquor Effluents and Ammonia Committee. During the year the investigations of the Research Chemist, Dr. Key, and his assistants have been concerned with the effect of gas-works liquors on the disposal of sewage by dilution, and on the treatment of sewage with activated sludge, or by bacteria beds. The question of the production of ammonium bicarbonate as a fertilizer has also been investigated. The Report shows that in places where a large volume of water is available for diluting the sewage and where this is consequently discharged untreated, the influence of a normal dose of crude or spent gas liquor is usually negligible. Even with such concentrations as 5% of liquor, little retardation of sewage purification was observed and the amount of extra oxygen consumed remained relatively small.

Tests with activated sludge indicate that, in certain circumstances, the conclusion arrived at in the 4th Report, to the effect that the Biochemical Oxygen Demand (B.O.D.) of a purified spent liquor mixture is little if any greater than that of the corresponding purified sewage, may require modification. It is now realized that, under specified conditions, such a mixture may have an oxygen demand much greater than, equal to, or much less than that of the corresponding sewage, depending on how far purification has proceeded.

In the presence of all the sludges studied it was confirmed that the oxidation of the organic constituents of gas-works liquors occurred very rapidly at first, leaving an Oxygen Absorption (O/A) residue which was very resistant to further attack.

Two investigations on the bacteria bed system of purification of sewage are reported, the one on the laboratory scale over a period of 12 months, and the other on the works scale at Leamington Spa over a total period of 5 months. The main result of the laboratory test has been to confirm those which had been previously made over much shorter periods. The averaging of a large number of B.O.D. tests clearly showed that, except with crude liquor in the very early stages, purification of sewage was in no way retarded by the presence of gas-works liquors.

The Leamington Spa Sewage Works, where the large-scale test has been made, and the methods of testing, are fully described. The general aim of the test was to compare the effluent produced by treating sewage on a set of percolating filters with those resulting from the treatment on similar sets of filters of the same sewage containing gas-works liquors, and to relate the results to those obtained from laboratory-scale experiments. The results demonstrated that, at Leamington, normal doses of either crude or spent liquor can be dealt with, the effluent still retaining its excellent quality. Even when the dose was equivalent to 0·5% of the sewage the spent liquor gave a perfectly good effluent and the crude liquor one which would generally be regarded as satisfactory.

The various investigations on ammonium bicarbonate are being undertaken in conformity with the views of the Liquor Effluents and Ammonia Committee that the possibilities of bicarbonate should be examined in case some alternative to sulphate was ever necessary and that the Institution should have a complete record of such possibilities. A further process for the manufacture of ammonium bicarbonate from crude liquor, which has been developed by the Research Chemist and his assistants, has been patented and is described in the Report. Further experiments which are being undertaken to determine the volatility of bicarbonate and the effect of the compound on the germination and growth of crops are briefly indicated.

In an Appendix to the Report Mr. P. Parrish (South Metropolitan Gas Company) contributes a Memorandum in which he expresses his personal opinions—technical and economic—on the by-product ammonia problem with special reference to ammonium bicarbonate.

Praise in Plenty.

The Report received a triple introduction at the hands of Mr. Botley, Prof. Cobb, and Dr. Key. Both Mr. Botley and Prof. Cobb pointed to the work done by the Committee in advising members who have difficulty in connection with the disposal of effluents and liquor. It was unfortunate, however, said Mr. Botley, that many of the undertakings who had sought advice had failed to inform the Committee as to whether this advice had been useful. Mr. Botley also pointed to the fact that there is now less tendency to rush for the destruction of ammoniacal liquor and more care is taken in considering methods of disposal. The discussion on the Report was really in the nature of praise for the excellent work of the Committee. Mr. Ramsden acknowledged the great help which the Leamington Priors Gas Company has received from the Committee and also from His Majesty's Inspectors of Alkali Works in this connection. Dr. Parker mentioned how closely the Water Pollution Research Board follows the Committee's work, while Mr. O'Shaughnessy, who referred to the disgusting practice of discharging untreated sewage into open water—by towns usually near the coast—spoke of the value of the work to those directly interested in sewage disposal and in the operation of sewage works. He reiterated his conviction that the work furnishes a classical example of the way in which an industry should deal with waste material arising during the course of manufacturing operations.

Research on Refractories.

Tuesday afternoon's proceedings were brought to a close by presentation and discussion of the Report of the Refractory Materials Joint Committee, of which Mr. W. Grogono is now Chairman. In the Report it is explained that study of the influence of the test conditions on the results obtained in the refractoriness-under-load test demonstrates that it is essential that definite standards of practice should be formulated. The Report deals with the definition of the height of the test piece. An American variant of the test, which indicates the stability of a specimen of refractory material on heating to and maintaining at a given temperature for a given time under a stated load, has been investigated in an extensive series of tests.

Work on the action of alkali vapours on refractory materials has been continued in a further series of experiments on the reactions of the vapour of potassium chloride at 1,000° C. on firebricks and silica bricks, under both dry and moist conditions. These investigations reveal striking differences in behaviour between silica and fireclay products.

Definite evidence exists that hydrocarbons can disrupt firebricks, and work which has been started on this subject clearly shows that gases which can react with one or more of the constituents in the body of a refractory product may, in consequence of this reaction, so weaken the structure of the product as to cause its eventual breakdown. Thus methane, under certain conditions, caused complete disintegration of firebricks, this being associated with the deposition of carbon, and, further, the " iron spots " were concerned in the action.

For some industrial operations refractory materials are required to be of low porosity. The effect of various conditions of manufacture have been studied and alterations in texture due to degradations in the size of the grains are described. On the other hand, the study of high-porosity silica bricks has been continued. This is being supplemented by similar experiments using sillimanite and other calcined refractory materials as a basis.

The Report also deals with the expansion-contraction characteristics of a number of synthetic cement mixtures, and the effects of additions of bentonite, fireclay and sodium silicate to crushed sillimanite, crushed firebrick and a crushed calcined clay are detailed. Measurements of the relative strength at ordinary temperatures produced by the addition of different cold setting agents to ground ganister are reported.

The Report concludes with a section on the Texture of

Refractories contributed by Mr. T. F. E. Rhead and certain of his colleagues of the City of Birmingham Gas Department. The section deals with the non-regularity of texture of gas-works fireclay refractories and its possible effect on durability and describes pictorial methods of recording the texture of refractories and similar materials.

Plea for Greater Support.

Mr. Grogono, who referred to the new Laboratories at Stoke-on-Trent, asked members of the Institution to encourage the assistance of the undertakings with which they are connected to subscribe directly to the funds of the Association. The same plea was also made by Mr. Frank West and Colonel Carr. The latter observed that many engineers now had 2,000 days' satisfactory working from segmental silica retorts, which is 25% in advance of what could be obtained 10 years ago and exemplifies the value of the work of the Association. Mr. West, referring to Mr. Rhead's Paper dealing with the texture of refractories, mentioned that the manufacturers are alive to the question and are doing a considerable amount of work on it, endeavouring to overcome certain difficulties which probably are in the manufacture, but possibly are not.

The introduction of the Report by Mr. A. T. Green was one of the outstanding features of the meeting and was thoroughly enjoyed. During the discussion Mr. Rhead, who commented on the great usefulness of the research work carried out at Stoke, showed about 18 lantern slides illustrating the texture of refractories, the relationship of texture to the life of refractories in use, and methods of recording texture both photographically and by ink impressions.

Membership of the Institution.

Before the close of Tuesday afternoon's session, the President made an important announcement in regard to the question of admitting as Members of the Institution technical workers in the Industry who are occupying positions of responsibility and who have attained the necessary eminence to admit them as members. It is generally appreciated that there are many technical workers contributing to the work of the Industry who would be most desirable members but who are not eligible for membership owing to the exact wording of the present Constitution. The Council, said Colonel Carr, have been applying themselves to the consideration of minor revisions which would allow not only technical workers in gas-works, but also members of the carbonizing industry directly concerned in carbonizing engineering, to become members. The Executive Committee of the Council feel that an attempt should be made to alter the Constitution to admit such people as members. It is hoped that other chartered institutions—the Institution of Civil Engineers in the main—will not take exception to this desire.

Street Lighting.

The first item of Wednesday morning's session was the Report of the Joint Lighting Committee, which was presented by Mr. Stephen Lacey. It comprises an account of the investigations of factors affecting the performance of gas street lamps; specimen records of examinations for test point illuminations; a model public lighting maintenance scheme; and a summary of conclusions of the Interim Report of the Departmental Committee on Street Lighting of the Ministry of Transport.

The results of the Investigation may be summarized as follows:

If the gas street lighting installation has been arranged to satisfy the requirements of any given Class in the British Standard Specification for Street Lighting, the gas engineer may confidently state that (*a*) the mean test-point service illumination can be maintained at 70% of the mean test-point rated illumination, assuming reasonable maintenance, and (*b*) any greater tolerance than 30% deprives installations of an advantage which can be legitimately claimed for gas street lighting.

Under normal conditions in towns partly residential and partly industrial, no great loss of light output will result from cleaning glassware once a fortnight instead of once a week.

Of the small light depreciation which does occur and which is usually attributed to dirty glassware and depreciation of light output from the mantles, an appreciable part is due to soiled injectors. Lamps to be preferred, therefore, are those in which the injectors can be easily removed without taking the mantles from the burners.

The life to be expected from mantles of good quality should not be less than 1,000 burning hours. Depreciation of light output due to mantles should not exceed 9% after 1,000 burning hours. Mantles are often removed from lamps and replaced by new mantles when the cause of depreciation lies in the burners or injectors. Recognition of this should ensure saving in the number of mantles used.

Use of Governors.

Presenting the Report, Mr. Lacey said that the Gas Industry has always contended that the allowance for depreciation in the B.S.I. Specification of as much as 50% is far more than is desirable or necessary where the lighting is by gas. He observed that no reference is made in the Report to the use of governors on the lamps tested. He urged the desirability, on commercial and other grounds, of maintaining the greatest practicable uniformity in all gas lighting installations, and recommended the use of governors on the lamps in all cases where the pressure is not known to be practically invariable during lighting hours. This matter was also referred to by Mr. Philip Sugg during the discussion. Half the troubles encountered, he stated, are due to alterations in pressure, and in his opinion a governor should be as standard on the lamp as is a speedometer on a motor-car.

Mr. Masterman's comments were confined to the Interim Report of the Departmental Committee of Street Lighting, of which Committee he is a member. He mentioned that the relative importance of road surface brightness had given rise during recent times to an immense amount of discussion, but as yet no one has been able to propose any quantitative definition of road surface brightness in relation to visibility which can be of value in any specification or installation requirement.

Mr. W. J. A. Butterfield summarized the impressions gained by the delegates appointed to represent the Gas Industry at the International Commission on Illumination held in Berlin and Karlsruhe last July.

New Meter Specification.

Next on the programme was the presentation of the First and Second Reports of the Meters Committee. The First Report reviews the development of the "Lights," "Standard," and "High Capacity" Meters, and the factors and statistics which had to be considered before preparing the Specification, given in the Second Report, for the "I.G.E. Gas Meter." The three sizes of this meter have rated capacities of 100, 200, and 400 cu.ft. per hour, a maximum speed of 1,000 revolutions per hour, and, *inter alia*, specified case dimensions. They are respectively regarded as being suitable for "prepayment," "ordinary," and larger "ordinary" domestic consumers.

Meter design and construction and the quality of materials have purposely been omitted from the Specification, but meter union sizes will have to accord with a British Standard Specification now being prepared at the request of and in collaboration with the Meters Committee.

Unless the Meters Specification of the Institution is generally adopted by the Gas Industry, the desired reduction in the number of classes and sizes of meters will not be effected and the position, instead of being improved, will be further complicated. It is recommended, therefore, that gas undertakings should in future order gas meters to comply with "The Institution of Gas Engineers' Specification for Gas Meters for Domestic Consumers."

Views of the Manufacturer.

The great desirability for unanimity in the adoption of the new Specification was stressed by Mr. John Terrace in presenting the Report. In the course of his remarks he quoted from a letter from Mr. Jamieson, of Edinburgh, who expressed entire sympathy with the proposals and with the clause limiting the number of revolutions to 1,000 an hour. Mr. Jamieson feels that the range of sizes of the meters specified will give a reasonable margin for different types of domestic consumer. Mr. Madden, too, referred to this point, and also mentioned that prior to the Specification a large number of different sized meters materially increased manufacturers' costs. On this last matter the comments of Mr. H. E. Bennet and Colonel Peebles were received sympathetically by the Meeting. Mr. Bennet explained the difficulty from the meter-makers' standpoint. A large body of people, he said, insist on having nothing but standard meters, an even larger body insist on the large-case high-capacity meter, while others insist on the small-case high-capacity meter. But the trouble does not end there. Many gas undertakings have individual specifications, and according to one maker actually twenty-one stocks have to be carried, and naturally this has a bearing on costs.

Mr. Jacques Abady suggested that consideration might

be given to the development of an inferential meter, perhaps on the anemometer principle, small in size but reasonably accurate to satisfy the Board of Trade. To this suggestion Mr. Lacey replied that the difficulty was to make such an instrument accurate throughout the whole range of registration required by the consumer. At certain times it might have to register a flow of gas as low as ½ cu.ft. per hour, while the next minute it might have to deal with a flow of, say, 150 cu.ft. On this occasion Mr. F. Thorp, who has had great experience in connection with the use and development of inferential meters, endorsed Mr. Lacey's remarks. He explained that during the War meters had been allowed to be installed for measuring substantial rates of flow, but that a minimum flow had to be specified below which the meter cut off. Obviously, such an arrangement would be quite impossible in connection with the supply of gas to domestic consumers.

Sulphur and Scaling of Steel.

Wednesday morning's session was brought to a close by consideration of the Gas Fellowship Report, 1934-35, which deals with the scaling of mild steel in sulphur-free and sulphur-containing furnace atmospheres.

The monetary loss resulting from the loss of even quite a small percentage of metal by scaling in furnace operations will, over a year, represent a very large sum. Experiments have been made upon small samples of mild steel, which were subjected to the action of different gaseous atmospheres—" neutral," oxidizing, or reducing—the scaling being measured by the increase in weight of the test piece in each case. The gaseous atmospheres were made up to represent the products of combustion of the different fuels—solid, liquid, and gaseous—which might be used in furnaces.

For the complete elimination of scaling by the use of reducing gases it was found that to a " neutral " atmosphere containing 10% steam, an addition was necessary of either 29% hydrogen, 95% carbon monoxide, or 21% methane. It is concluded that, where such complete elimination of scaling is sought, heating by simple and direct exposure to the stream of burning gas is wasteful and often impracticable, and that some other method should be employed.

Experiments in which a smoky atmosphere was used clearly indicated that the solid carbon particles in a smoky atmosphere have in themselves no appreciable anti-scaling value, and that the anti-scaling effect is derived from the accompanying clean reducing gases—carbon monoxide, hydrogen, and methane. Experiments were also made by the addition of free oxygen to a " neutral " furnace atmosphere. Its effect in producing scale was very pronounced, and the importance of its exclusion is obvious.

The tests plainly show that the best results as regards freedom from scaling will only be obtained from a furnace so designed, constructed, and controlled in use that an atmosphere containing no free oxygen and a minimum of steam can be consistently maintained. It is also clear that, although by the exclusion of oxygen and the use of reducing gases such as hydrogen, carbon monoxide, and methane, scaling can be very much reduced, complete elimination of scaling, as is sometimes required, can only be brought about efficiently by indirect heating, in which the bulk of the products of combustion does not come into contact with the metal.

Observations were made upon the effect on scaling of the sulphur content of the fuel, and the results indicated that the influence of sulphur compounds is remarkable in its magnitude. A comparison of unpurified and purified town gas, however, showed that the degree of purification from sulphur compounds effected in normal town gas almost eliminated the scaling due to sulphur, and there appeared to be only a slight further improvement resulting from more drastic purification.

A Sign of the Times.

Introducing the Report, Prof. Cobb suggested that its presentation to the Institution is a sign of the times. When the investigation was commenced they had not ventured to suggest that it ought to come within the orbit of the research work of the Institution, but nowadays, having regard to the importance of the industrial use of gas for metal heating, nobody would question the legitimate position of the Report in the Proceedings of the Institution. The Gas Research Fellow, Dr. H. C. Millett, then introduced the Report. Discussion on the Report was not lengthy, but the remarks of Dr. W. H. Hatfield have great significance in exemplifying the enormous developments which are taking place in the use of gas for metal heating and emphasizing the properties of gas which make it so eminently suitable for close control of furnace temperature and furnace atmosphere. Dr. Hatfield referred to the investigation as a magnificent piece of work, maintaining that the conclusions drawn in the Report are entirely justified by the experimental work on which they are based. That a great deal remains to be done on the relationship between furnace atmospheres and the nature as well as the amount of scaling produced is obvious from Dr. Hatfield's remarks. The speaker, by the way, paid high tribute to the work of the Sheffield Gas Company in co-operation with the iron and steel industry in the supply of town gas for heat treating.

Bringing the discussion to a close, the President mentioned instances where the saving effected by the substitution of coal gas for producer gas, by reason of the atmosphere conditions alone, in metal and in reduction of metal wastage, was more than the total cost of the fuel.

Holder Contamination.

On Wednesday afternoon we commenced with the Report on the Generation of Hydrogen Sulphide in Water-Sealed Gasholders contributed by the Gas Light and Coke Company and the South Metropolitan Gas Compay. This Report, which was presented by Mr. Hollings, deals with the causes of the formation of hydrogen sulphide in gasholders and methods of preventing or relieving such contamination. It is concluded that the production of sulphides by bacterial reduction of sulphate probably proceeds continuously in most gasholder tanks to a greater or less extent, and it is considered of the utmost importance that, in any cases where the generation of hydrogen sulphide in the holder is suspected, the gas entering and leaving the holder, and the water in the holder, should be submitted to precise chemical examination. Details of the apparatus and methods of control and of carrying out the analyses are given in the Report.

Contamination can be prevented or relieved by the addition of oxidants, with the object of removing the hydrogen sulphide from the water by oxidation to sulphur or sulphate; removal from the gasholder water of the sulphides or the sulphates from which they are produced by precipitation in an insoluble form; or the destruction of the reducing bacteria by the addition to the water of a bactericide.

The discussion on the Report was a relation of experiences rather than a criticism of the Report itself, which was acknowledged by all to be exceedingly helpful. Mr. Tarratt told of the trouble of sulphuretted hydrogen at the outlet of a holder in Newcastle two or three years ago, and said how useful it would have been to him had the Report been available then. Mr. Clarke related his experience at Whaley Bridge, and Mr. Parkinson, of the British Gas Light Company, spoke of how the advice contained in the Report had helped them to overcome the same trouble with a new holder at one of the Company's small works. The other speaker was Dr. G. E. Foxwell, who suggested that perhaps a solution to the difficulty lay in purifying the gas at the outlet of the holder.

The General Discussion.

This brought us to the final business of the meeting, which was a discussion on the First Report of the Research Executive Committee and on gas research and investigation in general. Considering all that has been mooted in regard to the organization of research within our Industry, we thought the discussion very disappointing. Mr. Tarratt asked for constructive criticism, but criticism of any nature was not forthcoming. It was mentioned by the President that research concerned with the efficiency of utilization of gas in connection with the Gas Fellowship Report is to be continued with the collaboration of the Iron and Steel Institute. Colonel Carr mentioned that he is finding more and more fields open for low-temperature heating work. He considers that there are great possibilities of extending business in this direction, and there are problems of heat transference at low temperatures—something less than 500° or 600° C.—which must be investigated. We have already mentioned in connection with the Report by Mr. Densham and Mr. Smith on Protective Coatings for Underground Pipes, that during the general discussion Dr. Beck and Mr. Ridge spoke critically of the authors' findings.

Vote of Thanks.

The Meeting closed by an omnibus vote of thanks to all those who had contributed to what was unquestionably a highly successful conference. The vote was proposed by Mr. E. P. Stevenson, and responded to by Prof. Cobb and Colonel Carr.

The Autumn Research Meeting OF THE INSTITUTION OF GAS ENGINEERS

THE PRESIDENT,
Colonel W. M. Carr, O.B.E., T.D.

Thirteen Reports were presented at the 7th Autumn Research Meeting of The Institution of Gas Engineers, held in London on Nov. 5 and 6, and, of these, eleven were discussed. We published in the "JOURNAL" for Sept. 11 last the Report on Protective Coatings for Underground Pipes, by A. B. Densham and F. C. Smith.

The 12th Report of the Gas Education Committee, 1934-35

Included in this report were the names of successful candidates in the 1935 Examinations of the Institution, as published in the "JOURNAL" for July 31 last (p. 261); the Questions set in the Examinations, published in the "JOURNAL" for May 15 and May 22 last (pp. 372 and 448 respectively); and also the Report of the Examiners—see "JOURNAL" for July 31 (p. 263).

The 1934 Revision of the Education Regulations, containing a comprehensive Index and all the amendments made up to and including the 9th April, 1935, has been published.

In order to ensure that all Approved Courses shall accord with current Education Regulations, the Regulations governing the Approval of Courses have since been amended to provide that, in future, approval shall be granted for a period not exceeding five years. All existing Courses will be reviewed and revised where necessary when they have remained approved for five years.

Commencing with the 1937 Examinations, candidates for the Higher Grade Examinations will be required, at the time of examination, to be or to have been engaged in Gas Engineering if candidates for the Gas Engineering Certificate, or in Gas Supply if candidates for the Gas Supply Certificate.

The Comparative Statistical Schedule of the 1934 and 1935 Examination Results indicates that the number of Examinees is being maintained. If the published figures of 445 Examinees in 1934 and 437 in 1935 are increased by adding the number of candidates who sat for the Examinations, but whose Results were not included,* the numbers would be 497 in 1934 and 512 in 1935.

There were no candidates for the Diploma in Gas Engineering (Supply) or for the Diploma in Gas Supply, and no candidate qualified to have his Gas Supply Diploma, obtained under the 1929 Revision of the Education Regulations, converted to the Diploma in Gas Engineering (Supply). The period during which application could be made for such conversion has now lapsed. No further Examination will be held for the Diploma in Gas Supply, its place having been taken by the Diploma in Gas Engineering (Supply).

The Charles Hunt Memorial Medals for 1935 are not awarded.

Approved Courses.

Four new Major Courses were approved by the Board of Education and the Institution during the year. Fourteen

*(*a*) Candidates having Second-Class Certificates who re-sat and failed to obtain First-Class Certificates; (*b*) Candidates whose examination has not been completed.

THE INSTITUTION OF GAS ENGINEERS.

COMPARATIVE STATISTICAL SCHEDULE OF EXAMINATION CANDIDATES 1926-1935.

Examinations	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
External—										
Diploma in Gas Engineering (Manufacture)	7	8	14	13	4	6	11	16	9	9
H.G. Gas Engineering	12	23	25	30	20	13	26	21	29	22
O.G. Gas Engineering	22	40	35	25	18	25	31	31	48	36
O.G. Gas Engineering (single subject)	..	..	..	10	..	..	1	..	1	..
Diploma in Gas Engineering (Supply)	..	..	..	..	..	..	..	1	..	..
Diploma in Gas Supply	..	..	3	..	..	..	2	1	1	..
H.G. Gas Supply	3	7	3	2	2	3	8	9	15	17
O.G. Gas Supply	19	18	35	33	22	12	13	19	21	26
O.G. Gas Supply (single subject)	..	..	..	12	4	6	2	7	8	9
Internal—										
H.G. Gas Engineering	27	18	38	41	55	54	77	59	83	54
O.G. Gas Engineering	47	48	34	59	56	53	70	61	46	52
O.G. Gas Engineering (single subject)	..	..	..	..	1	9	7	6	5	3
H.G. Gas Supply	2	9	15	20	24	41	47	42	49	66
O.G. Gas Supply	14	43	46	64	72	80	109	106	105	117
O.G. Gas Supply (single subject)	..	..	..	..	9	8	21	38	25	26
Total	153	214	248	309	287	310	425	417	445	437

of the forty-seven Centres with Approved Major Courses did not this year present candidates for the Main Subject Examinations.

Two Centres have been added to those having Approved Minor Courses in Gas Supply Practice and eleven to those having Approved Courses in Gas Fitting.

Introduction.

Sir FRANCIS GOODENOUGH, C.B.E.: I have the honour to present the 12th Report of the Gas Education Committee to this Autumn Meeting of the Institution and I do so with mixed feelings—partly of gratification at the steady maintenance of the excellent results of former years with even some small progress over previous records, and partly of disappointment at the lack of progress in one particular direction.

The number of examinees is maintained at no less than 512 for the year under review, as compared with 497 in the previous year, but while the Gas Supply examinees increased from 223 in 1934 to no less than 271 in 1935—the increase being almost entirely in internal students—it is with real regret that we record again an entire absence of Diplomas in Gas Supply. It is lamentable to think that of all the students who have taken first-class Higher Grade certificates in Gas Supply, in all no less than 113, there is such an absence of students (in all only 2) who have gone forward to win the diploma. Is it that the importance of highly qualified Gas Supply men in the Industry is not realized by the administrators and managers of undertakings? It would seem as though there must be some such explanation of this deplorable lack of candidates for Diplomas in Gas Supply, because the same lack is observed in students for diplomas in the commercial examinations under the British Commercial Gas Association's scheme. Are managers doing all they can to encourage students to go forward for the higher qualifications on the Gas Supply side? I am afraid that the answer is in the negative. In these days of growing stress in competition and of the daily increasing importance of first-class men on the commercial, the sales, and service side of our business, can we not all of us make up our minds to leave no stone unturned to see that the training of the rising generation of gas salesmen and gas supply technicians is the very best that can be secured, and that every facility and encouragement is given to our students?

The Committee propose to take what steps they can to get this question raised at the meetings of the District and Junior Associations of Salesmen's Circles, and I propose that we should circularize not only those organizations but all students who have achieved first-class certificates in Gas Supply and in Gas Salesmanship, pointing out the value to themselves and to the Industry of their going still further. It is of the greatest importance that all men who represent the Industry to, and form a connecting link with, the consumer should be as highly and skilfully trained as possible. This has been said before by others than myself, but it is obviously necessary to repeat and emphasize the truth, because the result to date is so disheartening. I may be told that the requirement of the presentation of a thesis by students aiming at the Supply Diploma is an obstacle. For some reason or other this appears to be regarded quite unnecessarily by many students as a terrible obstacle, virtually a bugbear. Many of you may remember that a similar state of mind existed among the engineering candidates some years ago. The examiners then took the wise course of publishing in the Technical Press a brief description of the kind of thing that was expected of diploma candidates and also a list of some simple subjects which constituted not an exclusive list but merely a guide to potential candidates. This action was evidently appreciated by the students and proved beneficial to the scheme.

Evidently, we must seriously consider taking some similar action in regard to students on the supply side.

May I conclude these brief remarks on a subject of outstanding importance to the Industry, by emphasizing the thanks expressed in the Report to the District Gas Education Committees (whose work has been, and is, invaluable to the Industry) and express my personal thanks to the members of the Gas Education Committee in general; to the Vice-Chairman, Mr. John Terrace, in particular (who has relieved me of much detail work throughout the year), and say how pleased we all were to welcome on to the Committee Colonel French, representing the City and Guilds of London Institute with whom we have always had close and friendly relations, yet have not before had a member as a representative on our Committee. I am very glad that that omission in the past has now been remedied. I beg to move the adoption of the Report.

The PRESIDENT: I should like formally to second the motion for the adoption of the Report, and in doing so I feel that we should support the action which Sir Francis has indicated is to be taken by the Gas Education Committee in calling the attention of students to the importance of the Diploma in Gas Supply. I think that we should all make it known that there are likely to be many more openings in our Industry in the future on the supply side than on the manufacture side. It is a trend of the times. There is a grouping of undertakings nowadays, but there will never be a less demand for the highly trained and skilled technical man. The technician is wanted more than ever in our Industry. We must be alive to the fact that he is going to be required more on the supply side, and the respective heads and administratives of undertakings should let it be known generally to their staffs—as I think we all know from our own experience in each of our undertakings—that we are extending our technical staff on the supply side to a very much greater extent than we can on the manufacturing side; they should let it be known that those openings exist and that the highly technical brains that we require on the supply side will not be in any shape or form less remunerative than the brains we require on the manufacturing side. Each of us in our undertakings can give a lead there to achieve the desired object of producing more highly trained technicians who have a better knowledge of the utilization of gas.

Discussion.

Mr. S. B. WATKINS (Association of Principals of Technical Institutions): As a representative of technical teachers in general and teachers of gas engineering in particular I should like to express our keen appreciation of the assistance we get from inside the Industry and of the continued interest and enthusiasm which is shown in the educational programme of the Institution, by its members. I have been associated since their inception with the short courses for teachers, which have been run by Mr. Creasey every year since about 1924, and I think I am known personally by and know personally practically every teacher of gas engineering in the country. I know I am voicing their sentiments in this respect in saying that we do greatly appreciate the assistance from within. It has taken some time to build up the educational scheme and system to its present state, but we do know, as the 12th Report shows, that things are beginning to move more smoothly; this is bound to lead to the recruitment into the Gas Industry of men more highly qualified than it has been our good fortune to recruit before. I think there has been criticism at various times, but it has always been helpful criticism, and I should like to congratulate the Institution and its Board of Examiners upon their sympathetic understanding of the position of the men who have to "put it over." I do not intend to enter into the discussion of the Report, but I should like to thank the Council of the Institution for its assistance and its kindly consideration of and regard for the teacher as that very necessary extra camel for The Institution of Gas Engineers.

Mr. C. H. CREASEY (Gas Education Committee): It is almost unnecessary for me to add anything to what Sir Francis Goodenough has said about the scheme. Apart from the lack of candidates for the Diploma in Gas Engineering (Supply), I think the members of the Institution have every reason to be satisfied with the Report. The numbers have risen to a figure which I think few of us ever anticipated they would reach. The machinery is working smoothly and owing to the activities on the District Gas Education Committees, there can be few, if any, potential students in the country who are not aware of the advantages of the scheme. But every movement has a past, a present, and a future. The Report deals with the past and the present, and I would crave the indulgence of the meeting to devote a few minutes to the discussion of some aspects of the future of the scheme. I agree with the President that the numbers engaged in gas engineering may probably remain fairly steady. We have reason to believe that there is an increasing number of men with University degrees or with National Certificates in Mechanical Engineering or Applied Chemistry entering the Industry, and as a rule they take the examinations in the education scheme in view of their relationship to admission to the Institution. On the supply side, on the other hand, I think we can look forward to steadily increasing numbers for some years. That department of the Industry is an expanding department and it will call for a greater and greater number of technically trained men to meet the conditions which arise. So far, I think, the University graduates who enter supply are engaged very frequently on highly specialized problems of utilization, and they do not display that anxiety to take the examinations in the education scheme which is almost universal among those who enter manufacture. On the other hand, we have evidence that men trained under the scheme in manufacture are transferring to supply, and that appears to be one means by which the supply side is recruiting its technical staff.

A Part-Time Scheme.

But the point which I am particularly anxious to refer to is that the scheme is a part-time scheme. A part-time scheme has certain very distinct advantages. The student has received and is receiving, and has obtained and is obtaining, practical experience, and he has therefore a framework of experience to which the academic instruction of the schools can be attached. But when that part-time instruction is given wholly in the evening it imposes a very severe strain even upon those who have the health and the zeal and capacity to profit by it, while it deprives them of a considerable amount of social life, which is not entirely without professional value. A considerable number of young men in engineering, building, and chemistry throughout the country are allowed one day or two half-days a week free in order to attend classes, and there are a very large number of centres in the country where there are technical colleges or universities at which instruction can be obtained in subjects ancillary to Gas Engineering or Gas Supply during the daytime. Hitherto it has not been found possible, except in a few isolated instances, to adopt this plan in the Gas Industry—and the exception includes gas fitting apprentices, at the lower end of the scale—and I am not rash enough this morning to plead for a drastic and wholesale change in practice. But I would urge upon you the desirability of selecting individual students, who have shown ability in their everyday work and who have displayed capacity and perseverance in their studies for the Ordinary Grade Certificate, to receive some of the advantages that are enjoyed by the younger members of the staffs in other industries. I have in mind more particularly instruction in the ancillary subjects for the Higher Grade Certificates in Gas Engineering and Gas Supply and for the Diploma in Gas Engineering (Supply).

I am aware, of course, of the fact that there is an enormous amount of routine work in every industry and that it is difficult to arrange for that work to be done if a man is away. But something of that sort has to be done if he is ill, and I think it ought not to be beyond the bounds of possibility to make regular provision for a condition that now occurs occasionally. In support of this proposal I can only remind you that the Gas Industry is performing a great public service. It is a national service in so far as it is concerned with the wise utilization of national resources and a social service in so far as it is improving the amenities of life. But these services are expanding services; they will expand with the advance of science and the progress of civilization and they will require for their effective performance the services of an increasing number of men with technical training and with vision. The Gas Industry has recognized that fact in its establishment of the scheme. This scheme is not extraneous to the Gas Industry; I would suggest that it is actually an essential part of the organization of the Industry. I would urge upon you that it remains for the Industry still further to afford such facilities as will enable the scheme to become of increasing value both to the Industry and to the public which the Industry serves.

Dr. P. C. L. Thorne (Gas Education Committee): You will notice from the first page of the Report the decision that schemes of instruction are approved for only five years. This may not at first seem to be a very important matter; but before the resolution concerning it was passed by the Committee it was usual just to approve schemes and leave it at that. I do not think there is any suggestion that the Gas Education Committee wants to change its mind every five years; but the Industry is progressing and our ideas of what the Industry requires in the way of education are progressing. From time to time we have to accept schemes of instruction which are not ideal but which represent the best we can get under the exigencies of local circumstances. The colleges vary in their possibilities and we accept the best we can get, provided it is above a minimum standard at the time. But the colleges themselves also improve, and the idea is that as and when they do improve we are able to secure a better and more satisfactory scheme by revision at the end of each five years. That leaves us, of course, with a certain amount of wood which may or may not be dead, in the shape of courses which have been approved without a time limit, but we are gradually revising those courses. Only this morning I received from a well-known large centre particulars of a course which has been in need of revision; in fact, it has been partly moribund for the last few years. So that the whole thing is in a constant state of alteration and improvement.

The Course for Teachers.

The other matter to which I wish to refer is the course for teachers, which I have had the honour to conduct for the Board of Education this year. The response to that was not so good as it has been; I do not think we should really expect it to be, for it has been running for many years and has exhausted almost the whole number of teachers of gas subjects in the country. Consequently, the Board has decided this year to allow the course to lie fallow for at least a year, and I hope that when it is revived, as I am fairly certain it will be in the following year, we shall have your enthusiastic support in the way of releasing employees to enable them to attend the course. I do not think I need say anything about the value of the course. Only the teachers who have not attended it have any doubts about its value.

There has not been a great increase in the number of Courses in Gas Engineering and Gas Supply, and I do not think that at present we can expect a great increase. Most of the centres are now well planned out, and only here and there shall we get a new course established. So that the forty or so we have at present will, I expect, remain a fairly constant number. The increase this year and during the last few years has been in the courses in gas fitting, and owing to conditions of employment in that part of the Industry it is essential that there should be many more centres of instruction in that subject than in gas engineering and supply. Many more people have to be catered for, and it is not possible for them to travel such long distances as do those who are studying the more academic side of the Industry.

The Education Committee has had before it very often this question of the Diploma in Gas Supply. Indeed, the subject is almost like King Charles' head, for it arises at almost every meeting of the Committee, and we should value very much the comments of representatives of the Industry on the arrangements for this Diploma. It is very difficult for us to see what is wrong with the arrangements, inasmuch as no candidates were produced in, say, the last two years.

What I have said will underline that the price of a good scheme of gas education is eternal vigilance on the part of the Gas Education Committee and ceaseless enthusiasm on the part of the Industry.

Mr. George Dixon (Nottingham): I notice that in Appendix 1 the number of external students is shown as being very much smaller than the number of internal students, although I find that the proportion of successes among external students is about as high as that among internal students. The point I wish to raise is whether the small number of external students is due to the fact that the country is well covered from the point of view of provision for internal students, or whether it is due to some other factor. I am interested because in my own district in Nottingham we may be in a slightly isolated portion of the country, and it has been difficult to provide for our students in Gas Engineering or Gas Engineering (Supply) as internal students. I think that at the moment, there being no classes held in Nottingham in the major subjects, they would have to travel 26 or 27 miles, which is just outside the practical economic radius. So that I feel that those men have got to become external students.

With regard to supply, again I find that the factor which reduces the number is, quite candidly, the expense of the correspondence course, which seems to me the only course open to them, and I am convinced that is largely the reason for the small number of your external students. I should like to ask if it is possible for the Education Committee to make some census of the potential number of students in the rather isolated districts. At any rate, if it were found that the numbers of potential students were such as to warrant it, I would suggest that either some negotiations were commenced with the correspondence colleges with a view to reducing their prices by reason of the greater numbers, or that the Institution should itself consider the question of starting some courses direct. I make that suggestion partly for the Industry and partly to help my own particular case, and I should like it to be considered by the Education Committee.

The Old War Cry.

Mr. John Terrace (Gas Education Committee): It was not my intention to say anything this morning, but when Mr. Dixon raises the old war cry that we heard some ten years ago, the old war horse must respond. The subject of the internal and the external student was a very thorny subject in the early days of the education scheme, and at one time it almost looked as though the whole scheme would be wrecked. Fortunately, as there are always two points of view and some have probably a good deal in them, wiser counsels prevailed, and we were able to modify the scheme in such a way as to render it possible for any students engaged in the Gas Industry, no matter what his place of residence or education might be, to take the examinations we were setting and to obtain certificates of equal value.

The point raised by Mr. Dixon, about students, and

especially the supply students, being unable to obtain instruction in the subjects on which they require instruction in order to gain their certificates, is a little complicated by the fact that the examination, whether internal or external, may really be divided into two parts, one part being the ancillary subjects, and the other being the main subject. They are not really divided, however, because you must have the one and the one must have the other. While we are fairly well satisfied in respect of the number of centres at which there is an internal course in both Gas Engineering and Gas Supply, we recognize that it is not always possible to run a course at each of these centres on the main subject; the number of students is not sufficient to justify it, and it is part of the scheme that students may take their ancillary subjects at a local college at which there is a very good, if not an adequate, supply, and take the examination in the main subject at the nearest town. They can then take it as internal students. If there should be no classes in the main subjects available they have then to take the main subjects as external students. But that is quite a simple matter under the scheme, and there is no need to go into it here.

As to the correspondence classes, the matter is left entirely to the student; in the event of his not being able to obtain instruction in the main subject at a suitable local college, he may use whatever means he likes to obtain his knowledge. We have evidence that there are people in isolated places who are really proving to be quite good people to take the examination.

As to the suggestion that we might take a census of all the people who are likely to sit for the examination, that is somewhat difficult. A good many problems have been put up to the Committee—which now works very smoothly indeed—and I might say to Mr. Dixon that we will consider the matter. At first blush, however, I personally do not see how we are to get very far with it.

The points concerning the education and the recruitment of students, and the help which the Industry might give by its efforts, have been very well put forward, and Sir Francis has given the usual résumé of what has happened, but the trouble nowadays seems to be that things are going along so smoothly that there is not very much to talk about. It is rather out of the ordinary, therefore, to find Mr. Dixon raising this old question.

One of the fears at the time we introduced the external examinations was that there would be a movement away from the colleges, and that more would take the examination as external than as internal students. We are very pleased indeed to find that that has not been the case, which goes to show the good commonsense of the students and of people generally; if courses are provided which they can reasonably attend, they take advantage of them.

Post-Graduate Training.

The PRESIDENT: Apropos the absorption of university graduates into our undertakings, a point with which I, and probably many others, have been concerned is the extent of post-graduate training and instruction that should be laid down for graduates who have taken, say, a degree in Gas Engineering at Leeds. In my own Undertaking the normal practice has been for a technical staff learner who is not attending a university to take a course of five years, extending from the time of leaving school, usually at the age of 17, until the age of 21 or 22. I have found that five years' course to be essential for the practical training in combination with the taking of the Institution's Examinations in both Gas Engineering and Gas Supply, which I consider that all students should take, whether they are entering the supply or engineering side. I believe that where a student has taken three years to graduate at the university, the post-graduate instruction can be covered in approximately two years. So that the graduate arrives at the same stage as the staff learner at approximately the same age, but the former has the added advantage of the university training, which should make him the more valuable man at the end of that period, though not necessarily, of course, for it depends entirely on the individual—the extent to which he has been able to benefit by his instruction.

I do think that is a matter for our consideration; perhaps Sir Francis and the Education Committee might consider the general policy of post-graduate instruction and training, although it is rather a matter for individual undertakings. I feel it would be a great help to graduates leaving the university if they appreciated the amount of practical training they would be required to do in the Industry when they have graduated.

Sir FRANCIS GOODENOUGH, replying to the discussion: I should first like to thank the old war horse for having replied to Mr. Dixon fairly completely; and I am sure we are all very delighted to know that that old war horse, who was in very indifferent health two or three years ago, is now so very much better and is able to give a jolly good kick when it is wanted. We promise Mr. Dixon that we will take his suggestions into very serious consideration, as well as those of the President on the question of post-graduate training.

I should like to thank Mr. Watkins for having opened the discussion and to say that the assistance from within, for which he thanked the Industry and which seemed to have surprised him a little, is not at all altruistic. As Mr. Creasey has said, the Education Scheme is part of the Industry, and unless we all recognize it as an essential part of the Industry we shall not get from it the results that we could and ought to get. A plea was made by Mr. Creasey for time off for students during the day in order that they might attend regular courses. He said that if a man were ill we should have to make some provision for doing his work, and he suggested that we should make provision for students as though they also were ill. Well, if you don't, the Industry will be ill, because it is more than ever true that this Education Scheme and its products are essential to the Industry. Reference was made by Dr. Thorne to students not taking the Diploma course, and he wondered what was the matter. I think it is cold feet principally. Students are rather afraid of tackling it because of the thesis bugbear to which I referred and with which we propose to deal.

One is glad to hear a discussion which shows that interest is being taken in the scheme by all parts of the Industry, and I would appeal again to all managers to do their utmost to increase the number of students at every stage in the course, not only at the Diploma stage but at the beginning, so that every young man in the Industry feels that his Chief expects him to improve himself, mainly for his own sake, but partly also for the sake of the Industry in which he is engaged and upon the progress and advancement of which his own future depends.

New Institution Members

The following were elected to the various classes of membership of The Institution of Gas Engineers on Tuesday, Nov. 5.

To Membership (2).

Downs, John Henry, Constructional Engineer, The Woodall-Duckham Companies.
Finlayson, Thomas Campbell, M.Sc., Deputy to Technical Director, The Woodall-Duckham Companies.

To Associate Membership (11).

Baker, Reginald, B.Sc., Assistant Engineer, Staines Station, Gas Light and Coke Company.
Caton, William Frank, Assistant to Chief Engineer and General Manager, Oxford and District Gas Company.
Cureton, Roy Stanley, Works Technical Assistant, Boston Gas Light and Coke Company.
Fitton, Geoffrey, B.Sc., Junior Assistant Engineer, Stroud Gas Light and Coke Company.
Gibson, Ralph Gordon, B.Sc., Engineering Assistant and Draughtsman, Liverpool Gas Company.
Hodgson, Harry, Senior Technical Assistant, Leeds Corporation Gas Department.
Kenyon, Geoffrey Holland, M.Sc., Assistant Engineer, Folkestone Gas and Coke Company, Kent.
Tiddy, Kenneth Edward, Engineer, Manager, and Secretary, Carmarthen Gas Company.
Turner, Cecil Rae Edwin, Assistant Draughtsman, City of Birmingham Gas Department.
Wilson, John Leslie, Technical Assistant, Kendal Corporation Gas Department.
Windiate, Gordon Harold Frank, Senior Technical Gas Salesman, Stretford and District Gas Board.

To Associateship (7).

Aldridge, Stanley, Manager, Gas Department, Reid Brothers (South Africa) Limited, Johannesburg.
Clark, Kenneth Lamphier, Chief Chemist, Weston-super-Mare and District Gas Company.
Pardoe, Thomas Harry, Senior Technical Gas Salesman, Stretford and District Gas Board.
Tarrant, Arthur Rex, Distribution Pupil, Croydon Gas Company.
White, Arthur Howard, District Superintendent, Shanghai Gas Company, Limited.
Wilkinson, Frederick Harold, Technical Director, George Waller and Son, Limited, Stroud.
Wood, John Robert, Chemist and Draughtsman, Farnworth and Kearsley Gas Company.

36th Report of the Joint Research Committee of the Institution and Leeds University

Corrosion from Products of Combustion of Gas.—Part III. Tube Experiments (*continued*)

Research Chemist.—James W. Wood, M.Sc.Tech., A.I.C.
Research Assistant.—E. Parrish, M.Sc.Tech.

The investigation continues the examination of the action of products of combustion of town gas upon typical materials used in the construction of gas appliances, and this Report is directed more especially to the effects of burning gases with a lower sulphur content than is at present common in town gas. The results are compared with those of the 34th Report of the Joint Research Committee, in which gases of normal and high sulphur contents were used.

A set of experiments is described in which a number of metal tubes have been simultaneously subjected to the continuous action of products of combustion under strictly comparable conditions for a period of six weeks, using gas with a sulphur content of 8 gr. per 100 cu.ft. (Similar experiments with gases containing only 4 gr. and less than 0·5 gr. respectively have also been made, but the necessary analytical work is not sufficiently advanced for the inclusion of the results in this Report.)

The experimental tubes were made from sheet metals, and were surrounded by water-jackets maintained at 40-60° F., whereby some 94 per cent. of the water produced by the combustion of the gas was condensed on the inner surface of the tubes; this, together with the sulphur and nitrogen acids dissolved therein formed the main corroding medium. The metals used are indicated in Table 1.

TABLE 1.—*Summary of Corrosion Tests.*

Average Operating Conditions.	Tests. III.	Tests. Ib.*	Tests. II.
Sulphur content of gas, grains per 100 cu.ft.	**8·1**	**25·6**	**81·2**
Duration of test in days	42	12	21
Gas consumption, cu.ft. per tube per day	12·73	11·66	12·21
Water produced by combustion of gas, c.c. per cu.ft.	20·4	19·4	20·2
Water condensed as percentage of that produced by combustion of gas, per cent.	94	91	94
Concentration of CO_2 in flue gases, per cent.	7·1	8·0	7·3
Dilution factor†	5·7	6·3	6·5
Sulphur content of flue gases, grains per 100 cu.ft.	1·43	4·09	7·93

Material.	Sulphur Retention in Condensate, Per Cent.‡ III.	Ib.	II.	Average Rate of Corrosion as Measured by Weight of Metal in Condensate, Grammes per 100 Cu.Ft. of Gas Burned. III.	Ib.	II.
1	2	3	4	5	6	7
Lead	11·4	9·6	7·1	0·019	0·013	0·008
Tin	12·5	8·2	6·5	0·003	0·006	0·007
Solder (1)	12·1	7·8	6·6	0·017	0·023	0·014
Solder (2)	12·6	..	5·9	0·016	..	0·012
Aluminium	50·0	19·3	15·4	0·15	0·18	0·23
Brass (70/30)	81·2	37·8	26·9	0·63	0·86	1·43
Copper, hard	90·3	42·3	29·0	0·69	0·97	1·54
Copper, soft	95·4	47·2	31·5	0·74	1·01	1·70
Iron, black	74·1	51·2	61·5	0·86	1·54	3·27
	..	..	..	(1·86)§	(2·20)§	(4·48)§
Iron, galvanized	91·1	82·9	77·3	1·20	2·84	4·73
Zinc	95·9	89·5	89·9	1·27	3·33	6·07
Nickel	92·4	..	..	1·10	..	..

NOTE.—Data in columns 3, 4, 6, and 7 are taken from Table 1 of the 34th Report of the Joint Research Committee, 1934, Communication No. 100.

* Run *Ib* followed without break Run *Ia* of 15 days' duration, using the same specimens of metal.

† Cubic feet of dry flue gases (*i.e.*, products of combustion + excess air) per cu.ft. of gas burned.

‡ Sulphur in condensate as percentage of sulphur in gas burned.

§ Corrosion corrected for metal in deposits adhering to tubes.

The gas used was town gas from which the sulphur compounds had been almost completely removed, and to which carbon bisulphide was then added to give the desired sulphur content. During the sulphur removal process the calorific value of the gas was reduced from 470 to about 450 B.Th.U. per cu.ft.

The course of the corrosion was followed by the collection of the condensates in 3-day batches which were subjected to chemical analysis to ascertain the amounts of metal, sulphur acids, and nitrogen acids they contained. Whereas with the gases of higher sulphur content the bulk of the corrosion-product had remained in solution, there was in the present series of tests a tendency for the condensates to throw down precipitates, and deposits forming on the walls of the tubes also became relatively more important in some cases.

The rate of corrosion from beginning to end of the tests (as judged by the amount of metal found in the condensates) was remarkably uniform for individual materials, and did not show the initial period of relatively severe attack noted in the 34th Report when using gases of higher sulphur content.

When the metals are arranged in order of resistance to corrosion, their sequence is substantially the same as that previously observed when burning gases containing 25 and 50 gr. of sulphur per 100 cu.ft. The order adopted in the 34th Report has therefore been retained in Table 1 of this Report.

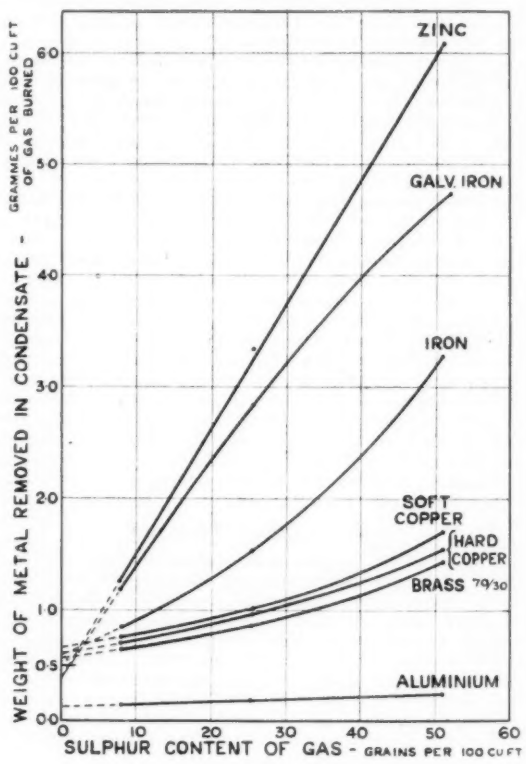

FIGURE 1.—*Variation of Corrosion with Sulphur Content of Gas.*

Consideration of the results as a whole shows that the metals fall into three main groups, exhibiting good, medium, and poor resistance to corrosion, respectively, under the conditions of testing. Lead, tin, and solder show a marked superiority over the remaining metals throughout; as the sulphur content of the gas is reduced, however, the difference between the metals of the middle group and those showing the least resistance to attack becomes less pronounced. In the case of iron a relatively large addition for metal in deposits adhering to the tube must be made to the amount of metal in the condensate in order to obtain the total corrosion.

When the figures of Table 1 (grammes of metal in condensate per 100 cu.ft. of gas burned) are plotted, as in Figure 1, to show the relation between sulphur content of the gas burned and the rate of corrosion, some important facts are disclosed.

The rate of corrosion falls as the sulphur content of the gas is reduced, but the fall is appreciably less than would

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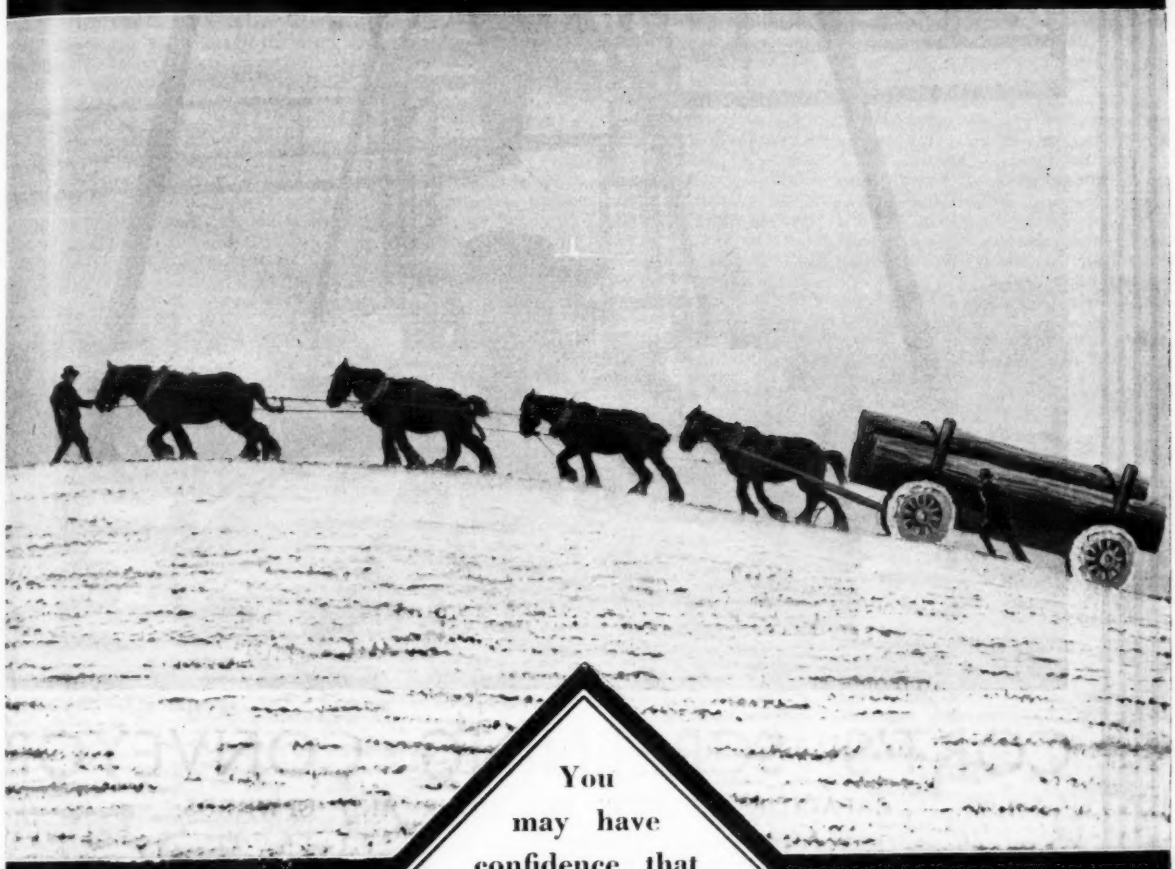

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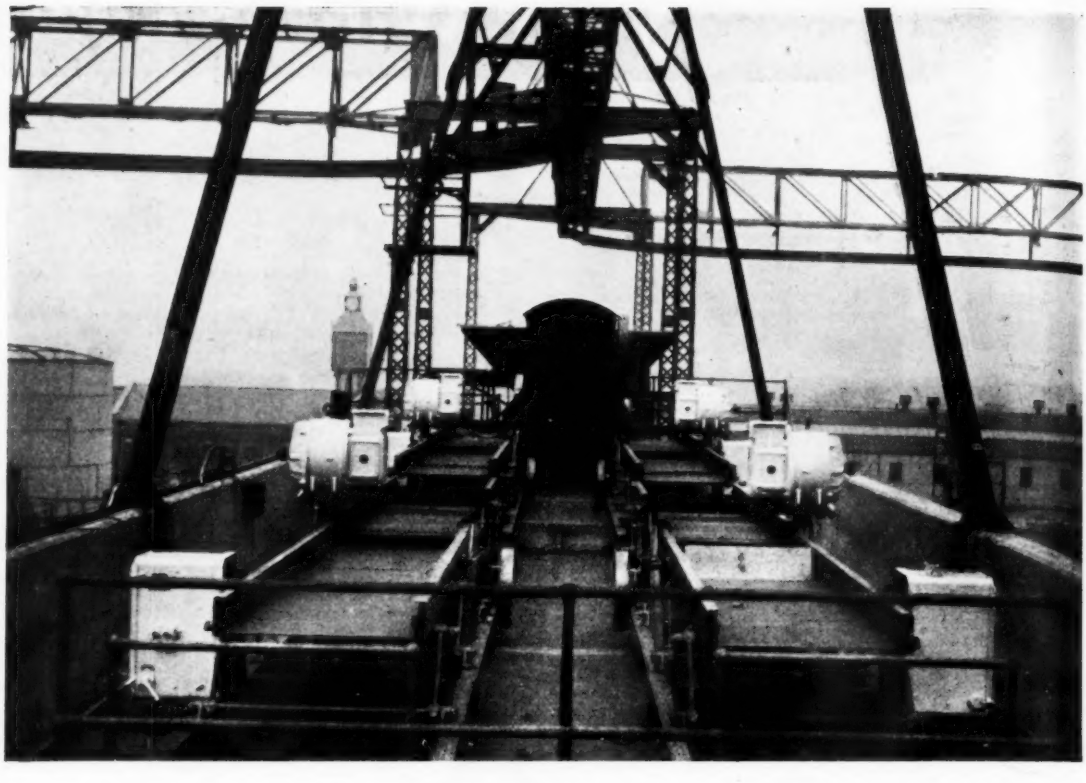

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be expected from the assumption that corrosion is proportional to the sulphur content of the gas.

The results show no evidence of a sudden drop in corrosion when sulphur is reduced below a certain value, but indicate that corrosion will still occur even if sulphur is completely eliminated. (The experiments with gases of very low sulphur content referred to above confirm this qualitatively, but a quantitative statement is not possible until the analytical work is completed.)

The amount of sulphur retained in the condensates (mainly as free and combined sulphuric acid) from the gas containing 8 gr. of sulphur per 100 cu.ft. varied from 11·4 to 95·9 per cent. of that in the gas burned, and was in every case a higher proportion of the sulphur originally present than was obtained in previous tests when using gas of higher sulphur content, although the absolute amount was of course smaller. The condensates contained a smaller amount of free acid than before (0·01-0·02 g. per 100 c.c. as H_2SO_4) which presumably accounts for the greater readiness of precipitates to form.

The amount of nitric acid found in the condensates was never less, and was in some cases appreciably greater, than in the tests previously reported with gas of higher sulphur content. The nitric acid thus becomes relatively more important as the sulphur content of the gas is reduced, and would in itself account for the failure of the corrosion curves of Figure 1 to pass through the origin at zero sulphur content.

The present experiments indicate that reduction of corrosion to a considerable extent could be effected by reduction of the sulphur content of town gas, and such a course would also have other advantages. They do, however, show that the complete removal of sulphur from town gas would not secure the complete elimination of corrosion.

Introduction.

The PRESIDENT: I call upon Mr. Hardie to present to you the 36th Report of the Joint Research Committee of the Institution and Leeds University. In doing so I should like to express our appreciation of the excellent work he has done as Chairman of this Committee over a number of years. We regret that he finds it necessary to give up this work, but we appreciate none the less all that he has done, and we feel sure that he will be ever ready with his advice and help when it is required in the future. I should also like to take this opportunity of expressing our pride and pleasure as an Institution in the fact that Mr. Hardie, one of our late Presidents, has been elevated to the Court of Directors of the great undertaking which he has served so admirably and which we hope he will continue to serve in his higher capacity for many, many years.

In referring to our joint work of research and investigation and also to the work that has been done elsewhere, I will add that during the year we have strengthened our contact with the Industry throughout the world, through the medium of the International Gas Union and the International Commission on Illumination. At the meetings with those bodies liaison was established with the Presidents and officials of the principal Continental Associations, and it is hoped that it will be possible to set up a permanent exchange of information between our own Institution and the Institutions of other countries. It would be impossible to over-estimate the importance of these international meetings of highly qualified technical men from every civilized country in the world. They point the way, I believe, to a new world order. In these days, when mechanical progress is moulding the nations of the world into a single economic unit, it becomes more certain that co-operation between the technicians of all countries is the surest way of preserving peace. I rejoice to think that our Industry should lead the way in establishing co-operation between the technical men of the Gas Industries in this and other countries.

Mr. THOMAS HARDIE (Chairman of the Joint Research Committee): I thank you very much, Mr. President, for your very kind words, and also all gentlemen present for their very kindly approval of them. I should also like to thank Professor Cobb for the very nice remarks he has made in his Report, which is at the beginning of the 37th Report, on the work of the Joint Research Committee. The work on that Committee has been very interesting and I have thoroughly enjoyed it. I have particularly enjoyed meeting the representatives of the Leeds University, who really have borne the heaviest part of the work of the Joint Research Committee.

I would add that in Mr. E. V. Evans, the new Chairman of the Joint Research Committee, we have a really excellent man for this work, and I hope that he will receive such support in the work he has to do as I have received since I have been Chairman.

(Professor Cobb and Mr. James Wood briefly introduced the Report.)

Discussion.

Mr. C. A. MASTERMAN (Gas Light and Coke Company): It is an honour to be called upon to open the discussion on a report representing one of the main lines of research carried out during the past year at the Leeds University. The results of such research should clearly be of great value to the Industry and few subjects at the present time are of more importance to the utilization side of the Industry than is the sulphur content of town gas and its results.

As a result of the sulphur content in the gas small traces of sulphur oxides are found in the products of combustion. Their importance is two-fold. On the one hand, it is their perceptibility in the diluted products of combustion which fixes a limit on the size of flueless heater which can satisfactorily be used in any given circumstances, assuming that conditions are not satisfactory to the consumer if the products of combustion are even remotely perceptible as a pungent smell. Where the sulphur content of the gas is high it may even be undesirable for this reason to fix a flueless heater of sufficient size to give adequate warmth to the room where the room is ill-ventilated. Where heaters are actually brought into use in these circumstances—and it is often beyond the power of the local gas undertaking to control them—they may create prejudice in the minds of the consumers against gas. Although this is an extremely important matter, it is one to which it is impossible to attach any specific financial value. We only know that where the sulphur content is high the undertaking must either itself discourage business in certain directions or must risk losing the goodwill of the consumer and so see business lost.

On the other hand, the concentration of sulphur in gas must be reflected to a greater or less extent in the corrosion of the gas appliance itself, and it is on this subject that Leeds University has now for some years been carrying out work. If complete quantitative information regarding this type of corrosion were available it should be possible to make a financial estimate of the savings in maintenance which would result from varying the degree of reduction in sulphur content and so show whether or not expensive changes in manufacturing processes could be justified on financial grounds.

In the present Report it is concluded that the rate of corrosion falls as the sulphur content of the gas is reduced, but that the fall is appreciably less than proportional to the changed sulphur content of the gas, and that the complete removal of sulphur from town gas would not secure the complete elimination of corrosion troubles. It is also concluded that lead, tin, and solder are the most resistant metals, followed by aluminium, brass, and copper with iron ranking still lower in the scale. These are important conclusions if they can be accepted for general practical application. Examination of the circumstances of the work shows, however, that the conditions chosen for test although they may sometimes obtain in practice are far from normal. Corrosion must necessarily be influenced by the constitution and concentration of the attacking acids and by such physical considerations as the washing away of corrosion deposits. In the tests carried out at Leeds condensation was almost complete and the results are judged chiefly by the amount of actual corrosion which has taken place. In practice condensation is usually far from complete, and the need for maintenance arises not from the complete destruction of the appliance by corrosion but by reason of the corrosion deposits building up to such volume as to interfere with proper combustion and performance. The commonest condition in practice is for water to be deposited in some part of the appliance, the condensation itself being influenced by the sulphur oxide concentration in the flue gases. The liquid film so formed runs to a hotter zone in the appliance and there re-evaporates, presumably as a fairly concentrated acid. At this point a corrosion deposition of increasing size is formed. Its damaging effect and therefore frequency of maintenance required is conditioned rather by the volume of the deposit than by the amount of metal affected. Where corrosion, for instance, is taking place on an aluminium wall the weight of the corrosion product may be very small indeed, but it may be extremely voluminous and therefore prejudicial at an early stage to the satisfactory operation of the appliance. Much can be done to diminish this effect by proper design of the appliance so that the most critical part of the flueway does not occur at a point where corrosion deposits are likely to build up.

Sulphur Content and Corrosion Rate.

I have been closely associated with some preliminary work carried out under these conditions, the results of which, quite naturally, are not in agreement with the conclusions of the present Report. We found that on copper the corrosion increased rapidly as the sulphur content of

the gas rose from 1 to 9 grains per 100 cu.ft., but that furtner increase of sulphur content showed a less than proportionate increase in corrosion. For instance, the amount of corrosion doubled itself between 2 and 7 grains of sulphur and then doubled itself again between 7 and 35 grains of sulphur. Similar discrepancies between our work and that of Mr. Wood occurred between the cases of aluminium and galvanized iron, but I would emphasize that our work was of a very preliminary kind which I feel justified in mentioning here only because there is room for doubt as to whether Mr. Wood's results are of general and practical application. The same point is borne out in some degree by the communication by Millett and Cobb to be presented to-morrow morning on "The Scaling of Mild Steel in Sulphur-free and Sulphur-containing Furnace Atmospheres."

I trust that such criticisms as I am making will not be mistaken for lack of appreciation of the accurate work which has been carried out and which is here reported. The firm establishment of any scientific fact can never be said to be waste of time, but I am a little sorry that the more practical and therefore the more urgent problems did not find an earlier place in Mr. Wood's programme. Nevertheless, the conclusions, although limited in scope, add further confirmation to the view that some definite savings in district costs are to be anticipated as a result of decreasing the sulphur content of the gas, a change which will at tne same time be accompanied by substantial benefits in connection with the use of flueless gas appliances of all kinds.

Dr. HAROLD HARTLEY (Radiation Ltd.): This question of corrosion of apparatus is one with which most manufacturers of gas appliances must have been concerned at some time or other. We ourselves have had to approach the question from a point of view somewhat different from that of Mr. Wood and his Assistant. Our concern has been to find materials which will resist attack by the products of combustion of coal gas, whether the conditions of use permit of appreciable formation of condensate or not. This matter is of special importance in connection with the design of water heaters, whatever their type—*i.e.*, whether they are designed for continuous or intermittent use. If corrosion of flue-ways can take place, then not only may an unsightly corrosion product thrust itself on the notice of the user, but, what is even more serious, there may be such increase of resistance to the flow of the burnt or burning gases through the system as materially to interfere with combustion. In general, water heaters are designed so that even at normal consumption there is not an excessive flow of air through the combustion chamber. This is necessitated by the demand for a high thermal efficiency. Further, in recent years there has been an increasing tendency to supply small instantaneous heaters having a relatively high gas consumption, and to fit these without flues. It will be agreed that in such cases it must be ensured that the standard of combustion shall be above suspicion.

Solid Products of Corrosion.

Mr. Masterman has already drawn attention to the conditions under which Mr. Wood's experiments were conducted. Some 94 per cent. of the water produced during combustion was condensed on the inner surface of his tubes, and I imagine that once an experiment was started, the tube remained wet throughout the whole period of the test. A condition which is particularly troublesome, and which often occurs in practice, is that in which condensate is formed during a short initial period of use, but for the major part of the working life of the appliance, hot gases flow over the metal surface without deposition of liquid. Under these conditions there may result accumulation of solid corrosion products liable to obstruct flue-ways. It is thus not unimportant, when considering Mr. Wood's results, to keep in mind the difference in density of the various materials subjected to attack, and to remember that the unit weight of the corrosion product of, say, an aluminium alloy may occupy very much more space than an equal weight of a corrosion product of a heavier metal, and might thus be more liable to cause choking of flue-ways and interference with combustion.

If for construction there are employed materials which it can be ensured will continue to resist the attack of the products, then the cost of the appliance may be increased by as much as 30 per cent., a very heavy charge to place on the consumer. In view of the amount of tinned copper employed in the construction of flue-ways of water heaters, Mr. Wood's comments on the formation of a protective coating which prevents further action are of interest. It is noted in his reference to this detachable film, which he finds contains some 20 per cent. of tin, that it is sufficiently thick to show interference colours. It may be that information could be obtained as to the nature of the material by an X-ray examination. If the Committee thinks that knowledge of the structure of the material would be of any assistance to the Industry, I shall be very pleased to arrange for such an examination to be made on our apparatus. It may be, of course, the substance has a very complex structure, and that a solution may not be easily possible. However, the matter could very readily be settled by taking a photograph.

Mr. Masterman has already dealt with the discrepancy between Mr. Wood's findings and those reported last year by Mr. Densham—reference was made to the possibility of there being a critical sulphur figure, 10 grains per 100 cu.ft., such that if the sulphur content of the gas were reduced just below this, considerable relief from the sulphur nuisance might result. I am, however, not sorry that Mr. Wood has not been able to confirm this finding under his conditions of test, as this 36th Report does emphasize the fact that the aim of the Industry should be complete elimination of sulphur. Even when sulphur is eliminated we shall still have the problem of dealing with the effects of such oxides of nitrogen as are formed during the burning of the gas. This will probably involve further work in the tracing of their origin, as I believe it will be found that the amount of nitrogen oxides generated is influenced by the composition of the coal gas.

In the Report attention is drawn to the fact that while the rate of corrosion falls as the sulphur content of the gas is reduced, the fall is less than might be expected to occur if it were only the sulphur products that were responsible for the attack on the metal. I did not quite like the particular wording used in the summary of the Report dealing with this fact, as it seemed open to the interpretation that perhaps the problem of sulphur removal need no longer be regarded as vital. I was, therefore, particularly glad to hear Professor Cobb say that the President had already approached him in connection with a preliminary examination of the possibilities of complete removal of sulphur. This job is one which the chemists will have to solve, and, in view of its importance, I hope full opportunity will be given to them to do so.

I was very glad to hear Mr. Masterman draw attention to the flueless appliance question. I wonder what proportion of the members realize the extent to which the presence of sulphur in coal gas restricts its use, and that even with a 20-grain gas, often we cannot use it for space heating in flueless appliances without producing sufficient sulphur products to be unpleasant. In view of the importance of ventilating thoroughly this question of the effects of products of combustion, not only on materials of appliances, but on conditions in living rooms, &c., when flueless gas appliances are employed, I think it would have been most helpful to the Industry to have had a discussion on Mr. Masterman's very interesting and valuable report which appears as Publication No. 116.

37th Report of the Joint Research Committee of the Institution and Leeds University

The Controlled Operation of a Carburetted Water Gas Plant—Part II.

Research Chemist.—F. J. Dent, Ph.D., B.Sc.

Research Assistants.—W. H. Blackburn, Ph.D.; N. H. Williams, M.Sc.

This Report discusses the results of the tests described in the 35th Report of the Joint Research Committee and the conclusions form a basis for plant operation.

The results show how the performance of a carburetted water gas plant depends upon various operating conditions, viz.:—

(1) The ratio of the volume of air supplied during the blow to the weight of steam supplied during the run, *i.e.*, the air/steam ratio.
(2) The relative durations of the blow and run periods.
(3) The blast pressure.
(4) The depth of the fuel bed.
(5) The size of coke.
(6) The operation of the self-clinkering grate.

The main conclusions are as follows:—

The charges for capital and labour are so important that, when using carburetted water gas as a coal gas auxiliary, the total costs of manufacture per therm C.W.G. of a given calorific value are a minimum when a plant is operated at a high output. To obtain the high output, (*a*), the blast pressure should be such that, with the temperatures in the fuel bed at the maximum allowed by clinker formation and wear and tear of the generator, the heat in the blow gases is no more than is required for carburetting, (*b*), the rate of steam supply during the run period should be as high as consideration for the quality of the B.W.G. will permit, unless the rate of oil supply then required leads to excessive loss of oil efficiency. With the rates of air and steam supply thus determined, the relative durations of the run and blow periods are fixed by the necessity of storing sufficient heat in the fuel bed during the blow to decompose the steam during the run.

The procedure outlined above depends upon the fuel being of adequate density to withstand the blast pressure required to control the heat in the blow gases. When this is not the case, operation is affected in a manner discussed in the Report.

At the output for which the total cost of manufacture is a minimum, the charges for raw materials and maintenance are relatively high as a result of the rapid rates of steam and oil supply used. When the demand for C.W.G. decreases, economies in raw materials and maintenance can be secured by suitably modifying operation. Thus, clinker formation and wear and tear are reduced by using a lower blast pressure, while improved decomposition of the steam and oil, and B.W.G. of better quality, result from slower rates of steam and oil admission. In addition, for circumstances in which surplus steam is not available from an independent source, the heat in the blow gases can be increased, with advantage, until the plant is self-supporting in steam.

A large proportion of the steam should be passed downwards through the fuel bed, for then there is less tendency for heat to leave the generator in the blow gas while there is an improvement in the quality of the B.W.G.

With coke of normal grade, nothing is gained by operating with shallow fuel beds under steady conditions; the fuel bed should be sufficiently deep to avoid excessive loss of sensible heat in the gases leaving the top of the generator, without being so deep as to restrict unduly the air supply. A temporary lowering of the fuel bed is a simple means, however, of preventing the temperatures of the carburettor from being affected by accidental variations in the moisture content or the size of the coke, or the nature of the ash.

The performance of the plant using a normal grade of coke (50 per cent., 3-2 in.) is in all respects better than with smaller grades. At the same time, no mechanical difficulties arise with the smaller grades and they can be used satisfactorily when their smaller monetary value compensates for the lower thermal yield and poorer quality of the blue water gas obtained, and when the full output is not required from the plant.

Operation of the mechanical grate at a slower speed improves the output, the quality of the B.W.G., and the yield of B.W.G. per 1,000 lb. of coke, mainly because, with a slower speed, a greater proportion of the steam can be supplied on the back-run. If the reduction of the grate speed is continued, however, a point is reached when clinker accumulation prevents further gains, by disturbing the conditions in the fuel bed.

Comparison of the results obtained on the self-clinkering plant used in the present investigation with those of tests[1] on hand-clinkered plants, showed that the self-clinkering generator is operated at a considerably greater output per square foot of cross section, and that, in spite of this, it gives a higher thermal yield of B.W.G. per 1,000 lb. of coke and also B.W.G. of better quality. The superior performance of the self-clinkering set depends mainly on an improved condition in the fuel bed.

The chief advantage of the generator boiler on a self-clinkering generator is to be regarded as a reduction of the charges per therm C.W.G., until it is established that, with the same fuels, an alternative design of self-clinkering generator, not depending upon a water jacket, can be operated at as high an output as the type tested. When the full output is not required, the presence of the boiler remains an advantage under circumstances in which it is economical in raw materials to maintain the plant self-supporting in steam.

In order to obtain the highest output and the greatest yield of B.W.G. from the coke, it is especially important to secure complete admixture of the blow gas and secondary air at the top of the carburettor.

The main points to be observed in controlling the operation of a water gas plant are summarized as follows:—

The controlled operation of a water gas plant depends mainly upon deciding which of the many factors involved is placing the greatest restriction on operation. Then, the full exploitation of the methods available for counteracting the influence of the particular factor should improve plant performance. It is believed that, in many cases, it will be found that the blast pressure in use can be increased with advantage, and also that the accepted standard for the percentage of carbon dioxide in the B.W.G. is too low when account is taken of the greater output obtainable when a higher percentage of carbon dioxide is allowed.

When the demand for gas permits, operating the plant at reduced output leads to B.W.G. of better quality, a greater percentage decomposition of the steam, a higher efficiency of oil-cracking and to less clinker formation. The procedure is warranted since the consequent reduction of the charges for raw materials and maintenance will more than counterbalance the cost of any additional labour required.

The observations to be made in controlling the plant according to the system outlined in this Report are few. The final adjustment of operating conditions depends upon regulating the steam supply so that the carbon dioxide in the B.W.G. is at an accepted limit or so that the heat in the blow gases is no more than required for carburetting or steam-raising.

Except in certain particulars, to which reference is made in the text, this Report supersedes the 35th Report of the Joint Research Committee.

(The Report was introduced by Professor Cobb and Dr. Dent.)

Discussion.

Dr. J. G. KING (Fuel Research Station, D.S.I.R.): I remember last year, when the experimental part of this Paper was first presented, that I ventured to recommend that this should be expanded to include a critical survey of the variables examined. Now that this has been done and we are presented with the result in Communication

[1] 7th Report, Gas Investigation Committee, Trans. Inst. Gas Engr., 1921–22, 71.
"The Manufacture of Gas," edited by H. Hollings. Vol. I., "Water-Gas," by R. H. Griffith (Benn, 1934).

122, I am sure we must all realize its considerable value to all interested in the economics of the manufacture of carburetted water gas. The amount of detail involved makes the Paper a mine of information; but the present task of discussion in a brief space of time is a difficult one, and it is not possible to do more than refer to a few important points. The Paper concerns a C.W.G. plant as a whole, and consideration has been limited to conditions providing not only heat for carburetion but for raising all process steam. The treatment of the subject is therefore much more involved than the relatively more simple case of plain water gas. In addition, output rather than efficiency has been given the greatest consideration since capital charges have a greater effect on costs than those for raw materials. On this account there are certain limitations to the theoretical side of the work which should be remembered when reading the Paper. For example, a limitation is imposed upon the rate of blowing by the necessity for having in the blow gas sufficient heat for carburetting. In the more simple case of blue water gas the only limitation to increase of efficiency by increasing the rate of blowing is the stability of the fuel bed. In this sense increase of rate is of course accompanied by a corresponding decrease of time so that the heat release in the fuel bed is the same. Dr. Dent himself refers to this, and it has long been appreciated in American practice.

Cyclic Variations of Temperature.

An interesting feature of the Paper is the attempt to define conditions which reduce the amplitude of the cyclic variations of temperature which are inevitable in an air-blown plant. Dr. Dent shows that these variations tend to reduce process efficiency. One condition is the reduction of the time of the complete cycle to a minimum. The practical minimum is obviously less in an automatic plant; but the very real danger arises that the thermal losses by incomplete purging may exceed a reasonable figure. In this connection perhaps I might refer to some old experimental data collected from a H. & G. plant embodying a combustion chamber and waste-heat boiler but no carburettor. A purge period of 15 seconds at the end of the blow was necessary to give a blue gas of 290 B.Th.U., but this involved a thermal loss of as much as 18·5 per cent. A shortening of time of the cycle is therefore an expedient which should be approached with some caution. A suggestion which might help in this direction is that the efficiency of purging might be increased by applying some form of streamlining to certain parts of the plant.

Dr. Dent has described interesting experiments upon the effect of the size of the coke. In these he has kept the blast pressure constant and the same cycle so that the volume of air blown per cycle has decreased with decreasing size and the rate of steaming had to be decreased accordingly in order to give a gas of constant composition. Under these conditions he finds that decrease of size decreases sensible heat losses and increases the potential heat of the blow gas. He attributes both effects mainly to the greater thermal capacity of unit volume of the fuel which gives a more concentrated reaction zone. This does not, however, seem to account for the increase in the proportion of carbon monoxide in the blow gas accompanied as this must be by a lowering of working temperature.

In certain Fuel Research experiments (Tech. Paper 43, 1935) on size of fuel, when we used the same volume of air per cycle, the same rate of steaming and the same cycle it was found that the thermal output remained about the same for each size although the temperature (measured by optical pyrometer) fell in the case of breeze by about 100° C. We attribute this fall to the greater surface of the small coke and to the greater rate of reaction with steam. Unfortunately we were not able to follow up this observation; but we came to the conclusion that, given a higher blast pressure—*i.e.*, a higher temperature—we could have largely increased the thermal output by using small fuel. This higher output could also be assured, though to a less extent, by increasing the *time* of blowing; and I suggest that Dr. Dent could have increased his time of blowing and achieved a similar result although at the expense of greater heat loss as carbon monoxide. In his experiments the case is, of course, rather different, since his blast pressure could not be increased and his blow period was 40 per cent. of the total cycle as against 26 per cent. in ours. Nevertheless, I should be glad to hear his opinion.

Finally, I should like to congratulate Professor Cobb and Dr. Dent upon an excellent Paper which I am sure will form a valuable text-book for some time to come for all technical people interested in the manufacture of carburetted water gas.

Dr. R. H. Griffith, D.Phil. (Gas Light and Coke Company): The present report has been written with the purpose of showing how the efficiency of operation of a water gas plant may be made as high as possible, both in the direction of thermal yield from coke and oil, and of reduction in the total cost of gas. With this end in view it is desirable to consider two different points, (*a*) how to run existing plants of various types, and (*b*) how to select the proper type of unit for a new installation.

The general conclusions arrived at may be applied readily to the former of these two points, because, although the tests were confined to a set containing the back-run and a self-clinkering grate with annular boiler, no entirely new principles have been established. The losses which lead to inefficient working still fall under the same headings as those which have been recognized by previous contributors to the subject, and the vital importance of a proper balance of blow and run, together with a selection of optimum proportions of upward and downward steaming, is again emphasized. This emphasis is made more clear in the method of expressing the results of coke and oil gasification as separate items; this method of treatment, however, must not be carried to extremes, because there is a definite demand on the performance of the generator due to the heat required in the decomposition of gas oil.

When we come to the second point, and discuss the selection of a new unit, there are a great many more factors to be considered. Those of primary importance are (1) the back-run, (2) the self-clinkering grate, and (3) the provision of steam supplies for the plant. The views of Dr. Dent on these three points are quite clearly expressed in his Report, but I would like to comment on them in rather more detail.

The Back Run.

The amount of additional heat which is returned to the generator from the cracking vessels in the form of superheat in the back-run steam is about 1·5 per cent. of the total input to the generator, while the superheated steam lost on reversal of the gas flow is approximately half this amount—*i.e.*, the heat abstracted from the cracking vessels is thus about 2·25 per cent. of the input to the generator. Another gain with the back run is due to the fact that back-run gas leaves the generator at a lower temperature than up-run gas leaves the superheater.

Against these advantages may be set the drawback that the time available for oil cracking is considerably curtailed, so that it is more important to make a high quality blue gas, and it also may be necessary to operate the cracking vessels at a higher temperature. Further, if it is agreed that the plant should be operated so that it is self supporting in steam, it must be noted that the back run reduces the quantity of steam raised in the waste-heat boiler by about 10 lb. per therm of blue water gas. Without the back run, therefore, the air/steam ratio can be reduced to a lower figure before a deficiency of steam occurs. The extent of this decrease is difficult to calculate exactly, but from Table 14 of the Report, it should be easily possible to operate with an air/steam ratio of 34. This alteration would give an increase from 79·5 to about 84 therms per 1,000 lb. of coke, derived from Figure 5. In this respect the back run appears at a disadvantage. The economy observed in taking back-run gas directly from the generator to the wash box could be equally well attained by leading down-run gas to the wash box, as is done in the Chrisman down run. It is suggested that more attention might be given to the operation of ordinary down-run sets along these lines.

The Self-Clinkering Grate.

The effect of this grate on the output is very marked, and there can be no doubt as to the advantage of continuous ash extraction. At the same time, it does not appear to be established that the water-cooled grate is essential in order to gain this advantage, nor that the annular boiler confers any positive benefit on the performance of the generator. Additional steam is raised by the jacket, but could be provided more efficiently in the waste-heat boiler with a corresponding slight decrease in the necessary air/steam ratio. Direct comparison between brick-lined and annular boiler sets is only legitimate with units of approximately equal grate area. Under these conditions the following capacities will apply approximately. Taking the output of the hand clinkered set at 100 vols. per hour, the back run would raise this to 110. The use of higher blast pressure would increase the latter to 137, and the self-clinkering grate, together with both the previous modifications, would give 170 vols. per hour owing to the absence of stoppage for clinkering. Table 12, of the present Report, however, only indicates an increase in capacity to about 120 vols. with the self-clinkering grate when allowance is made for actual running time, so that the annular boiler clearly does not provide any greater capacity than might be anticipated.

It is suggested that efforts should still be made to

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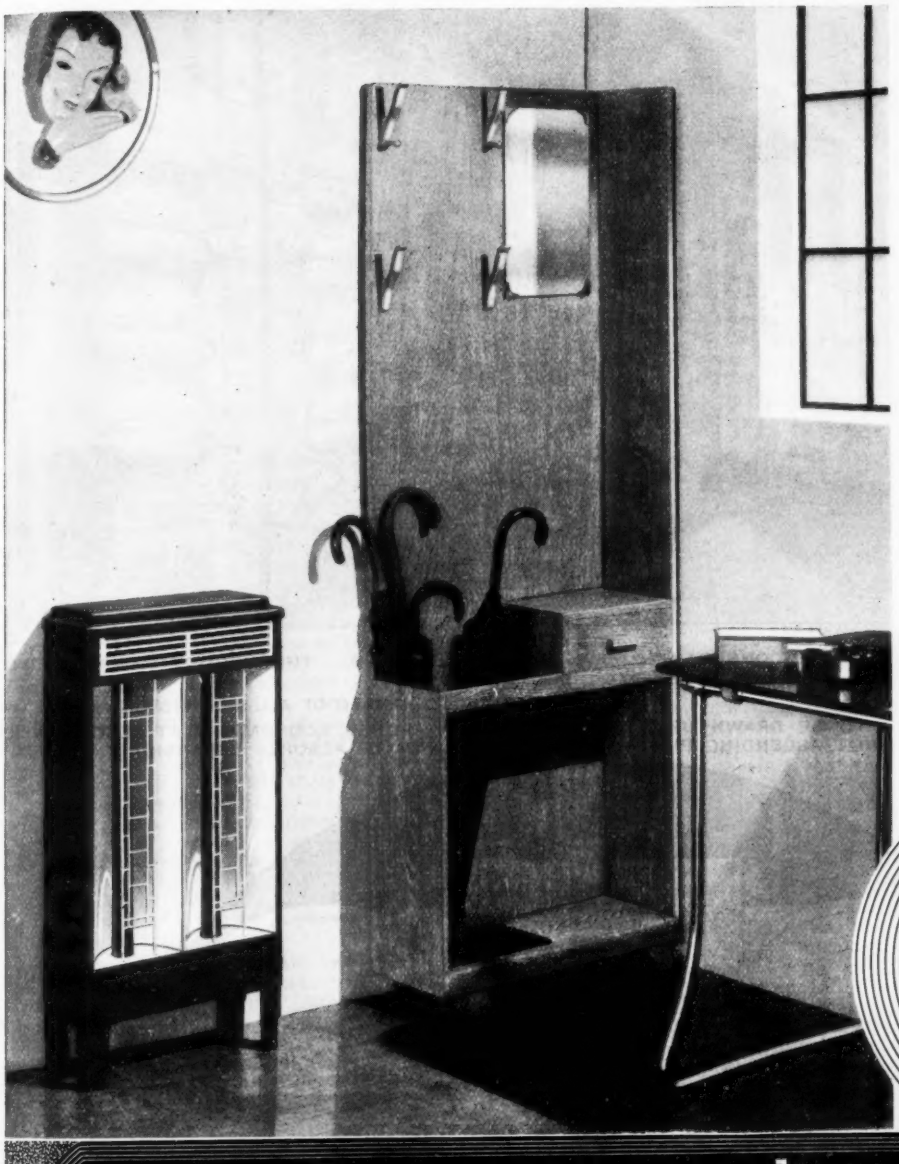

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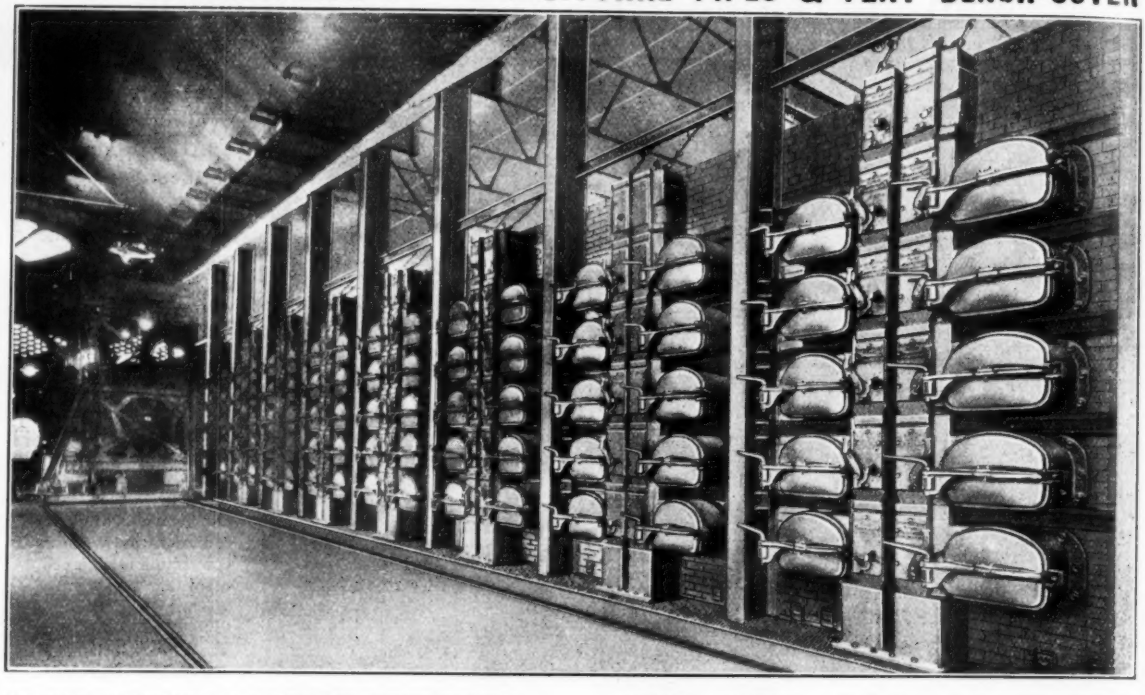

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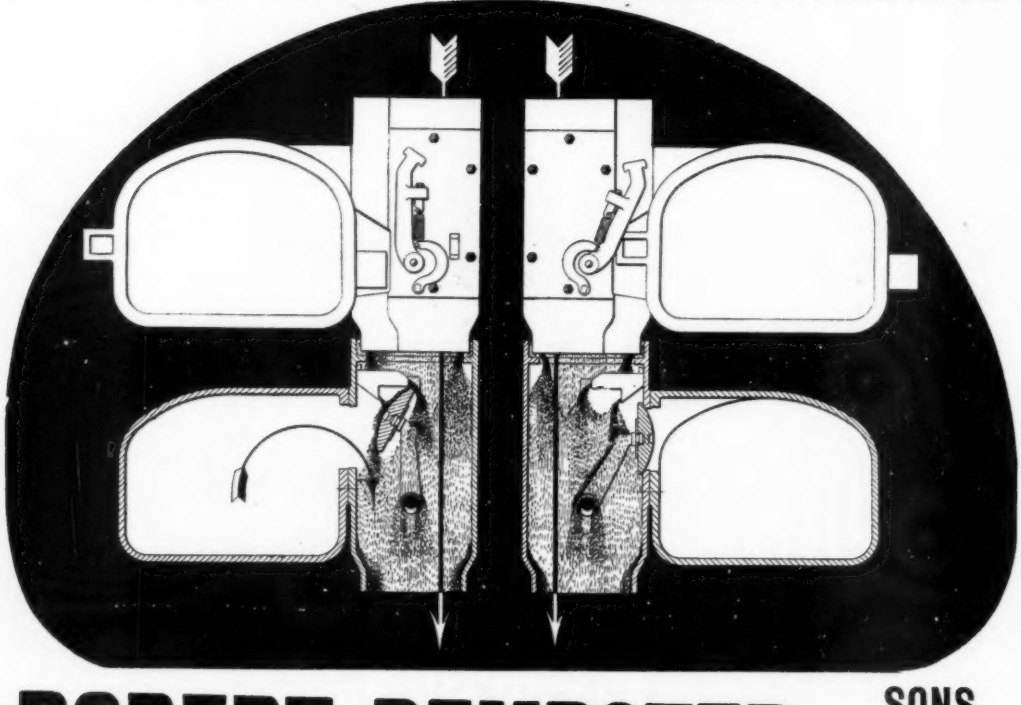

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eliminate the annular boiler, or at least to reduce it considerably in size, as was emphasized by Mr. Hollings during discussion of the 35th Report. The elimination might be achieved either by cooling the generator walls with air, or by supplying air to the fuel bed in such a way that excessive local heat is not developed and clinker formation is never allowed to occur. This can only be attempted by some sub-division of the air supply to the fuel bed.

Immense Care.

Mr. J. M. WEBBER (Croydon): Dr. Dent's final report is of particular interest to those of us at Croydon who were privileged to watch him and his assistants at work and who were able to see, in a small degree, the results of his tests as they appeared one by one. It might be thought that to those who have stood at the side of the stage and have watched the rehearsals, to those who have seen the conjurer put the rabbit in the hat beforehand, the actual performance must be an anticlimax, from which all interest has long departed. On the contrary, however, we appreciate this Report all the more for having seen Dr. Dent's methods and watched the immense care with which each figure was obtained.

We have not yet had time to digest the Report fully, but there are one or two points that occur to one on first reading it. We do appreciate the way in which Dr. Dent has considered costs all through his investigations and has not confined himself to purely technical considerations of efficiency.

In the first paragraph of his introduction he states that "In the broadest sense cheapening water gas manufacture entails reduction of the sum of the constituent charges—viz., those for raw materials, capital, labour, and maintenance per therm of gas made. . . . On this basis the charges for capital and operating labour are less the greater the output of carburetted water gas."

Now it is, of course, true of any productive plant that the greater the output the less is the capital cost per unit of output; but I would suggest that this is a very dangerous line of reasoning. The true cost of a process—the cost that affects the profit and loss account—is the total expenditure over, say, a year, and not the cost per therm or per ton. Thus, if a water gas plant is erected the undertaking is saddled with a fixed burden of capital as a charge of so many pounds a year whether the plant works at full capacity or whether it is idle. In the case of water gas plants, which must be ready in case of a sudden demand for gas, the total cost of labour may be almost as fixed a charge as that of capital. It would appear, therefore, that in considering how to operate the plant to the best advantage we should ignore these charges entirely, considering them rather as an insurance premium paid to obtain two advantages—(*a*) a supply of gas available at very short notice in an emergency, and (*b*) a saving on works costs due to the fact that it is cheaper and more convenient to be able to adjust the make of gas under rapidly varying loads by means of a water gas plant than by alterations to the working of retort houses.

I do agree with Dr. Dent when he says, later, that "once capital charges have been accepted the aim in operation is to minimize the remaining charges while supplying the prevailing demand for gas, a demand which is usually subject to fluctuation. Then, when the greatest output is not needed, economies in raw materials and maintenance can be secured by modifying operation."

Large Units More Economical.

It so happens that it is more economical, for several reasons, to install a few large automatic water gas plants than a number of small units, and thus it may happen, and in fact does happen at Croydon, that during the summer the amount of water gas required is not sufficient to keep even one set in full operation all day. We therefore have to decide whether it is more economical to work this plant, say, four hours out of every eight, or to try to adjust conditions so that the output of the plant per hour is halved, and so work it continuously.

Dr. Dent investigated this matter very thoroughly and shows clearly in his Report that quite a considerable saving can be effected by taking the latter course. The data he has prepared and the suggestions he makes for plant control in these circumstances are most valuable. How far it is possible to effect these savings in actual practice however must be found by very careful consideration and by trial. In the winter months the full output of a plant can be used, if not continuously at any rate for such a period as to make it not worth while to attempt any alterations in working. In spring and autumn, when weather conditions can alter gas consumptions so enormously in a few hours, it may be found that although the load factor of the plant, taken over 24 hours, is poor, we cannot afford to restrict the maximum output, as this must be available at a moment's notice. We have only one works which has to take all the fluctuations of output, and this has an important bearing on the problem.

In the summer, for several months, it may be possible to lower the output of the plant and so effect some savings, although even then the hourly consumption of mixed gas varies greatly, and a safe minimum holder stock must be maintained. Thus it might be necessary to work the plant at full make for a few hours during heavy consumptions and then drop back to a very low demand. Dr. Dent's tests were carried out under expert supervision, which was more continuous than can be provided in ordinary works routine, and I think he will agree that in some of the periods when one system of working is being changed to another very careful control is necessary. Bearing in mind the true function of a water gas plant, I think that only a practical trial of the methods he indicates will show whether it is really going to pay to take full advantage of them.

At the same time, he has given us a wealth of information as to the running of water gas plants in varying circumstances, and we are deeply indebted to the Research Committee and to him for this.

Author's Reply.

Dr. DENT, replying to the discussion, said: I thank you all very much for the manner in which this Report has been received. The discussion has not been very prolonged, but a number of interesting points have been raised and the remarks I make now are just those that occur to me directly at the moment, and will no doubt require amplification in writing later.

The first point raised by Dr. King was that high blast pressures are common in American practice. That is quite true, but the fact that they are not common over here in England—and I think our tests indicate definitely that they would be of great advantage—gives ample excuse for emphasis. The use of high blast pressures in America is often associated with the dense cokes used there and with the high fusion points of the ashes in the cokes; but as I said when introducing the Report, we have not by any means arrived at the limitations of our own cokes in that direction. The second point raised by Dr. King related to incomplete purging and short cycles, and he quoted a figure of 18½ per cent. loss by purging. That figure greatly exceeds anything with which we have come into contact. Generally, when carrying out tests on plants we adjust carefully the length of the purges, watching the nitrogen in the gas carefully at the out meter and at the exhauster; adopting such a practice on a modern Humphreys & Glasgow plant, allowing between 4 and 5 per cent. of nitrogen in the gas, there is no need to lose more than 1 per cent. of blue water gas by purging. That is the figure which will correspond with the 18½ per cent. mentioned by Dr. King, and which I think is excessive.

The streamlining question was also mentioned. The importance of streamlining has not occurred to me, naturally, as I have not met the difficulty of loss on purging. On the other hand, we have encountered the difficulty of providing proper and adequate mixing of the blow gas and secondary air. On the water gas plants which we have tested the mixing of the secondary air is much more important than obtaining streamlining through the checker bricks.

5th Report of the Liquor Effluents and Ammonia Committee

Research Chemist: A. Key, Ph.D., B.Sc.
Research Assistant: W. Etheridge, B.Sc., A.I.C.
Temporary Research Assistant: A. H. Eastwood, Ph.D., B.Sc.

Work on the disposal of gas works waste liquors has again been confined to investigations on the influence of these liquors on the properties and purification of sewage. In places where a large volume of water is available to dilute the sewage, this is often discharged untreated, purification subsequently occurring through the agency of the organisms present in the sewage and the oxygen contained in the diluting water. In these circumstances it has been shown that the influence of a normal dose of gas liquor, crude or spent, is usually negligible. The phenols in the liquors are rapidly and completely oxidized, but utilize only a small fraction of the amount of oxygen required by the sewage during the same time. Higher tar acids are quickly but only partially oxidized, leaving an oxygen absorption (O/A) residue as in other systems of purification. Thiocyanate remains unaltered for several days, but it is eventually oxidized when suitable bacteria have developed. Ammonia is also without effect until the later stages of the oxidation, when oxygen is required for its conversion to nitrite and still later to nitrate. These processes, however, do not occur until a week or a fortnight after mixing, and are of no practical importance.

Experiments with abnormally large ratios of liquor to sewage were necessary to obtain quantitative results, but even with such concentrations as 5 per cent. of liquor little retardation of sewage purification was observed, and the amount of extra oxygen consumed remained relatively small. The conclusion reached in the 4th Report that where direct discharge of untreated sewage is permissible no problem of the disposal of gas works liquors should normally exist, therefore receives ample support.

Conclusion No. 6 is the only one out of the thirteen set out in the 4th Report of the Sub-Committee which requires modification as a result of a further year's work. It was there stated that the Biochemical Oxygen Demand (B.O.D.) of a purified spent liquor mixture is little if any greater than that of the corresponding purified sewage. It is now realized that in certain circumstances such a mixture may have an oxygen demand much greater than, equal to, or much less than that of the corresponding sewage, depending on how far purification has proceeded. This is shown in a striking manner in the investigation on the activated sludge process. Normally this process is so operated that, while the carbonaceous matter of the sewage is destroyed, the ammonia remains unoxidized. Under these conditions there is every reason to believe that the conclusion quoted above holds good. The sludge may, however, be in such a state that when aeration of sludge and sewage is finished the oxidation of ammonia may be in progress. The effluent from a plant in such a condition would have a high B.O.D., because of the oxidation of ammonia continuing during the period of the B.O.D. test. In such a case gas works liquors, particularly crude liquor, by retarding the oxidation of ammonia, would reduce the B.O.D. considerably. Alternatively the sludge may be capable of carrying the oxidation of ammonia to completion in sewage alone before the aeration is finished, in which case the effluent would contain little oxidizable matter of any kind and would have a small B.O.D. With a liquor-sewage mixture such a sludge would probably only effect partial oxidation of ammonia, and this would continue during the B.O.D. determination giving a high oxygen demand.

The effects of sludges in all these conditions on other properties of sewage mixtures, notably the O/A, which may be greatly increased by an accumulation of nitrite, and the effect of the liquors themselves on the sludges, have also been studied. It was noted that sludge which treated a mixture of sewage and crude liquor was much denser than the normal, a fact which should simplify its ultimate disposal, and also that, volume for volume, it had a greater general activity in addition to special activity towards the constituents of the liquor.

In presence of all the sludges studied it was confirmed that the oxidation of the organic constituents of gas works liquors occurred very rapidly at first, leaving an O/A residue which was very resistant to further attack.

Two investigations on the bacteria bed system of purification of sewage have been carried out during the year, one on the laboratory scale over a period of 12 months, and the other on the works scale at Leamington Spa extending over a total period of 5 months. The main result of the laboratory test was to confirm those which had been previously made over much shorter periods and to add weight to the conclusions then drawn. The averaging of a large number of B.O.D. tests clearly demonstrated that, except with crude liquor in the very early stages, purification of sewage was in no way retarded by the presence of gas works liquors. Neither liquor appreciably affected the B.O.D. of the purified or partially purified sewage except when nitration was complete with sewage alone, but incomplete with the liquor mixtures, which then gave a rather higher B.O.D. This stage occurred after section 5 of the experimental filters.

The Leamington Spa sewage works, where the large-scale test has been made, and the method of testing, are fully described. The general aim of the test was to compare the effluent produced by treating sewage on a set of percolating filters with those resulting from the treatment on similar sets of filters of the same sewage containing gas works liquors, and to relate the results to those obtained from laboratory scale experiments. The effluent produced from sewage alone was almost completely nitrated and had a low O/A and B.O.D. The addition of 0·25 per cent. of spent and crude liquors (which is the average dose at Leamington) did not appreciably affect the effluent. Nitration was still almost complete and the O/A and B.O.D. were but slightly increased. Throughout the test crude liquor proved rather less amenable to treatment than did spent, due, no doubt, to its higher ammonia content. With a dose of 0·5 per cent. of liquors the effect on the O/A was still comparatively small, indicating more complete oxidation of organic matter than was effected on the laboratory sectional filters. Part of the increase in O/A was due to an increased nitrite content in effluents from sewage-liquor mixtures. The presence of the liquors also increased the amount of nitrate formed, but the oxidation of ammonia was not in these cases complete, a small amount still remaining in the mixtures after treatment. This ammonia, of course, increased the oxygen requirements of the effluents, and the rate at which oxygen was utilized has been the subject of special study. At 18° C. it was found that the oxygen required by all the effluents was about the same for the first four days, after which the rate of absorption greatly increased in those effluents containing ammonia. As a result, the 5 day B.O.D. test gave higher values for the effluents from mixtures containing 0·5 per cent. of liquors, particularly crude liquor, but the importance of the increases due to liquors was much reduced because of their being almost entirely confined to the fifth day. If the B.O.D. determinations were carried out at temperatures above 18° C., say 20-23° C., the differences were greatly magnified because of the acceleration of the conversion of ammonia to nitrite. At lower temperatures the differences disappeared.

The conclusion is that at Leamington normal doses of either crude or spent liquor can be dealt with, the effluent still retaining its excellent quality. Even when the dose was equivalent to 0·5 per cent. of the sewage the spent liquor gave a perfectly good effluent and the crude liquor one which would generally be regarded as satisfactory. There seems no reason why these results should not apply to other places with similar conditions. Where conditions are different it is not possible to apply the Leamington results directly, but a forecast of the effect of adding liquor to the sewage to any particular plant can be made by relating the Leamington test to a small scale experiment, taking into account the conditions of the plant. The Leamington test has confirmed the laboratory results recorded in the 4th Report of the Sub-Committee and the conclusions there drawn should therefore be generally applicable to large-scale practice.

Although the liquors at Leamington contained a large proportion of higher tar acids and the sewage-liquor mixtures were highly coloured, no trace of colour was ever visible in the effluents.

AMMONIUM BICARBONATE.

In the Third Report of the Liquor Effluents and Ammonia Sub-Committee a process for the manufacture of ammonium bicarbonate, which had been patented on behalf of the Institution,[1] was described, and the results of laboratory scale research work into the fundamentals of the process were reported. It was also stated that preliminary fertilizer experiments, carried out by the Agri-

[1] B. Pat. 393,678.

cultural Department of the University of Leeds, had given favourable indications and that at the time the Report was published systematic experiments on a more extended scale were in progress at the Rothamsted Experimental Station.

The official report on the results of these latter tests was received early in December, 1933. The work had shown that ammonium bicarbonate is a useful fertilizer, but had failed to establish whether or not it is equivalent to ammonium sulphate. In a few cases the increases in yield due to bicarbonate were significantly less than those given by sulphate; this might have been due to loss of ammonia by volatilization from the soil, to a toxic effect of the "free" ammonia on the growing plants, or to a reaction of bicarbonate with phosphates in the soil producing insoluble compounds. The lack of rain during the year might also have had an adverse effect on the bicarbonate plots. It should be noted that no attempt was made to develop special methods of application of bicarbonate to the soil; the standard practice used for sulphate was adopted. Many of the trials, however, were quite favourable to bicarbonate, so that taken as a whole the results were inconclusive.

Shortly after the receipt of the report, a special Sub-Committee, consisting of four members of the Liquor Effluents and Ammonia Sub-Committee and the Chairman, was set up to make a detailed study of the whole question of the manufacture and use of ammonium bicarbonate. The terms of reference were to consider the practical and commercial advantages and disadvantages of the several processes for the manufacture of ammonium bicarbonate, as compared with each other and with those for ammonium sulphate. Subsequently the terms were extended to include ammonium chloride and concentrated gas liquor. The Sub-Committee has now presented its report to the main Committee.

In the meantime a further process for the manufacture of ammonium bicarbonate has been developed by Dr. Key and his assistants, and an application for a patent[2] for this has been made. The process appears to be simple and to offer other advantages over that previously described, and a brief account of it is given below.

An average ammoniacal liquor contains approximately the amount of carbon dioxide necessary to form bicarbonate with one-half of the "free" ammonia present. The first stage of the process consists in obtaining the whole of this carbon dioxide in the gaseous form mixed with half the "free" ammonia, and allowing this mixture to form bicarbonate, whilst later the remaining ammonia is used to extract a further supply of carbon dioxide from the crude gas.

It is known to be possible to remove almost the whole of the carbon dioxide from a crude liquor without losing more than a trace of ammonia. This is what is effected in the decarbonation process which precedes distillation in the preparation of concentrated ammonia liquor. There must therefore be some point in the distillation process where the liquor has lost the whole of its carbon dioxide and one-half of its "free" ammonia. In the present scheme distillation is interrupted at this point, and the liquor immediately proceeds to another still, conveniently situated below the first still. The carbon dioxide and ammonia evolved up to this point are in approximately the correct ratio to form bicarbonate, and they are allowed to do so, either with or without the preliminary removal of excess steam. The formation of the bicarbonate is effected by washing the gases with a solution already saturated with ammonium bicarbonate. Absorption of both ammonia and carbon dioxide is fairly rapid and complete even at temperatures of the order of 40° C., so that cooling of the solution presents no difficulties. The solution itself provides a reservoir which corrects any irregularities in the composition of the gas leaving the still. The bicarbonate is crystalline and loses ammonia at a slower rate than the commercial salt. The solution contains little excess ammonia and is therefore not difficult to handle; it is thus unlike the solution in the previously suggested process, which had a high concentration of ammonia.

The partially distilled liquor from the first still contains about one-half of the original "free" ammonia but no carbon dioxide. This ammonia is driven off in the second still and collected as a relatively concentrated, say, 5 to 10 per cent., solution. After cooling, this solution is fed to a scrubber situated in the crude gas stream between the condensers and the ammonia washers. In this scrubber, the ammonia solution rapidly extracts carbon dioxide from the crude gas until the ratio of ammonia to carbon dioxide in the solution is approximately the same as in crude liquor. The solution then flows to the liquor well or is returned immediately to the first still, where it re-enters the process. During the scrubbing process some ammonia is lost from the solution to the gas, but this is of little significance, since the loss is small and it is only necessary to pass a fraction of the crude gas through the washer in question. Any ammonia which is lost in this way is easily re-extracted in the ordinary scrubbers. Thus, the only outlet for ammonia from the process is as bicarbonate, which is in a particularly pure and stable form.

Experiments on the laboratory scale on this process have proved very satisfactory and it now awaits a trial on a larger scale.

The Committee is satisfied that ammonium bicarbonate can be produced in full-scale practice from gas works liquor and that with the best of the processes proposed the cost of production should, under certain circumstances, be less than that of ammonium sulphate from the same source. An exact comparison of costs cannot be made without a large scale trial of one or more of the processes, but the advantages of bicarbonate over sulphate will be largely controlled by the cost of the sulphate radical in the latter product.

The Committee feels, however, that under present circumstances it would not usually be advisable for gas undertakings to produce bicarbonate in preference to sulphate or concentrated liquor. Before such a change could become general, it would be necessary for a new selling organization to be created and suitable propaganda to be undertaken. Knowledge of the capabilities of bicarbonate as a fertilizer has not yet reached a stage which would justify any such steps being taken. A further economic point is that if bicarbonate were generally produced the demand for sulphuric acid would fall and this would react unfavourably on the value of another gas works product, spent oxide.

Although no immediate production of large quantities of bicarbonate need be anticipated, it is felt that investigations into its possibilities should be continued. Since the main outlet for the product would probably be as a fertilizer, it is very desirable to have further authoritative information as to its properties as such, compared with other nitrogenous fertilizers, especially sulphate.

When a nitrogenous fertilizer is applied to the soil, the ammonia is taken into the soil by a base exchange process and is largely oxidized before assimilation by the plants. Any differences between different sources of ammonia must therefore show themselves either before these processes have occurred or in the substances left after the transference of the ammonia to the soil. The fact that sulphate leaves sulphuric acid, and bicarbonate only carbonic acid, is in many circumstances a point in favour of bicarbonate. Before this stage is reached, however, it is possible that bicarbonate might lose some ammonia to the atmosphere, thus reducing its fertilizing effect, or that the "free" ammonia in the salt might injure the growing plant. Neither of these effects is shown to any extent by sulphate. It has been decided, therefore, that investigations for the time being shall be centred mainly on these possibilities. Tests on the loss of ammonia from bicarbonate on the soil are being carried out by Dr. Key on an experimental plot of ground provided by the Coventry Gas Department, while the effect of ammonium bicarbonate on the germination and growth of crops is being studied in the Agricultural Department of the University of Leeds. These investigations are not complete, but present indications are that ammonium bicarbonate can be applied to the soil in such a way that neither loss of ammonia nor injury to plants can occur; on the other hand, unless care is taken, it is possible that trouble from both these causes may arise.

Of the processes for the manufacture of the salt which have been brought to the notice of the Bicarbonate Sub-Committee (those of Still,[3] Wilson,[4] Key,[5] McLaurin,[6] Lewis,[7] and Parrish[8]), that described above and due to Dr. Key appears to offer the most promising possibilities for operation on a gas works, and an opportunity is, therefore, being sought of trying out the process further on a small works scale. Information was made available to the Committee as to the probable cost of manufacture from concentrated liquor by the Parrish process; this process is normally intended for a central chemical works.

The Sub-Committee did not feel that at the moment any useful purpose would be served by further considering ammonium chloride, although it should be possible to manufacture this substance without the purchase of any expensive reagent.

The Committee still adheres to its recommendation that undertakings should give serious consideration to the possibilities of the production of concentrated liquor for sale to

[2] Pat. Appl. No. 12,553/35.

[3] D. R. P. 362,378.

[4] B. Pat. 319,441.

[5] B. Pat. 393,678, Pat. Appl. No. 12,553/35.

[6] B. Pat. 360,613.

[7] B. Pat. 14,618/95.

[8] B. Pat. 379,319.

a central works for conversion into sulphate or other product. It is pleasing to note that there have been considerable developments in this direction during the past year and that many plants have been erected. It is believed that with prices at the present level and with the use of automatic plant many undertakings are working the process at a profit.

MEMORANDUM CONTRIBUTED BY P. PARRISH.

The following Memorandum has been prepared by Mr. P. Parrish, M.Inst.Gas E., M.I.Chem.E., F.I.C., Manager, Chemical Works, South Metropolitan Gas Company. At the request of the Liquor Effluents and Ammonia Committee of The Institution of Gas Engineers, Mr. Parrish has agreed to the inclusion of the Memorandum, which represents his personal opinions and not necessarily those of the Committee, as an Appendix to the 5th Report of the Committee.

The By-Product Ammonia Problem, with Special Reference to Ammonium Bicarbonate.

The Liquor Effluents and Ammonia Committee has rightly persisted in its efforts to find a solution of the by-product ammonia problem. Indeed, such a solution is within sight, because a successful attack has been launched on the stronghold—the stronghold favouring the surreptitious waste and destruction of gas liquor—in two significant directions.

Firstly, the adoption of a large number of automatic plants for the manufacture of concentrated gas liquor and recent improvements which have been introduced have advanced matters materially. It is now possible, by controlling the proportions of ammonia, water, and carbon dioxide, passing to the condensing portion of a concentrated gas liquor plant, to manufacture concentrated gas liquor containing 20 per cent. of ammonia by weight, having a specific gravity greater than that of water. This can be effected without sensibly increasing the consumption of steam, and without involving process labour. All that is required is occasional supervision of the plant, to ensure that the controls are lubricated and maintained in clean and proper condition.

Secondly, economic methods have been found for the utilization of concentrated gas liquor, in the production of sulphate of ammonia of attractive quality, and of phosphatic-nitrogenous and phosphatic-potassic-nitrogenous fertilizers of a granular character.

The manufacture of the foregoing products cannot fail to develop.

There are other directions in which it is conceivable that the by-product ammonia position can be still further fortified.

Nitric acids and nitrates (calcium, sodium, and potassium) can be manufactured more cheaply from by-product ammonia than from nitrogen and hydrogen by synthetic means. This has been rendered possible by the automatic production (without involving labour) of an ammonia liquor, the ammonia of which can be readily volatilized and oxidized by the Ostwald process to nitrogen oxides, which can be converted inexpensively, in a combined sulphuric-nitric-acid plant, to nitric acid, from which nitrates or fertilizers containing "nitrate" nitrogen can be manufactured.

Again, there are distinct potentialities surrounding the manufacture of ammonium bicarbonate. Indeed, it is this product—its utilization, manufacture, and the economics of manufacture—that has evoked this contribution.

The Liquor Effluents and Ammonia Committee has latterly instituted experiments directed to determine whether ammonium bicarbonate, when applied in various ways as a fertilizer, is as good as, or better, or worse than sulphate of ammonia. These findings will be awaited with interest. Indications are not wanting which reveal that for certain applications ammonium bicarbonate will be as serviceable—ammonia unit for ammonia unit—as sulphate of ammonia.

There are, of course, other directions in which ammonium bicarbonate can be utilized for purposes other than as a fertilizer, but it is not regarded as opportune that reference should be made to this aspect in this contribution.

The writer has interested himself in a process, which has been protected, for the manufacture of ammonium bicarbonate, designed essentially for central chemical works disposed at strategic points throughout the country. On the other hand, the Institution has been granted patents for the process of Dr. Key for the manufacture of ammonium bicarbonate, which is capable of application at gas works and involves only slight modification of, and additions to, existing gas works plant.

The writer's views as to the best method of attacking the problem of the manufacture of ammonium bicarbonate are indicated below.

(1) If fertilizers are to be manufactured to-day on a competitive basis, it is essential that these should be manufactured on an economic scale. It is not always easy to define what is meant by an "economic scale." Some judgment can be formed by a knowledge of what is considered an economic unit of plant as applying to the manufacture of other chemical products. Thus, for example, a calcium superphosphate plant to-day would be regarded as uneconomic if it produced less than, say, 75,000 tons per year; a phosphoric acid plant would be deemed as operating under adverse conditions if it produced less than 30 tons of phosphoric acid (30 per cent. P_2O_5) per day; a by-product ammonium sulphate plant should have a capacity of at least 20,000 tons per year to be economic in these days; and certainly, no plant for the manufacture of ammonium bicarbonate should be of less capacity than 7,500 tons per annum.

(2) The production of ammonium bicarbonate as a fertilizer, on an economic scale, involves chemical engineering processes, and demands a different type of personnel from that which is normally found at the average gas works to-day.

(3) If uniformity of quality, suitability of packing, and efficient distribution of a fertilizer are to be ensured on an economic basis, large-scale units are indispensable.

In affording the above indication, the writer has no desire to reflect unfavourably on the application of Dr. Key's process, which technically is well-conceived and is fundamentally sound. Suitable conditions for its adoption may well exist.

The Manufacture of Ammonium Bicarbonate.

The manufacture of ammonium bicarbonate is effected according to the following reaction:—

$$NH_3 + CO_2 + H_2O = NH_4 . HCO_3$$

which is reversible, and the equilibrium constant can be expressed as:—

$$K = \frac{pCO_2 \times pH_2O \times pNH_3}{pNH_4 . HCO_3}$$

Provided solid ammonium bicarbonate is present, its partial pressure will remain constant. If the reaction is effected in contact with a saturated solution, the partial pressure of the water may be regarded as a constant and the above expression simplified, thus:—

$$K = pCO_2 \times pNH_3$$

Hutchison (J.C.S., 1931, p. 410) has determined values for the above constant. Such average values are:—

180 mm. at 20° C. and
29·5 mm. at 10° C.

The same worker has conducted experiments which have shown that with saturated solutions of ammonium bicarbonate the partial pressures of CO_2 and NH_3 were as follows:—

Temperature: 25° C.	
Partial pressure of CO_2	89·5 mm.
Partial pressure of NH_3	1·98 mm.
$K = pNH_3 \times pCO_2$	177

Equilibrium is only slowly and with difficulty attained. Thus, the tendency is for experimental results to be lower than actual values.

With the writer's process, which provides for the manufacture of ammonium bicarbonate from concentrated gas liquor, it is recognized that the reacting gases attain equilibrium more rapidly in solution than in the dry state.

The first step is to bring CO_2 or CO_2-containing gases, in excess of the equilibrium proportions, in intimate contact with the concentrated gas liquor at such a rate as to allow of (*a*) decomposition of the ammonium sulphide of the concentrated gas liquor and the formation of ammonium bicarbonate, and (*b*) the conversion of the normal ammonium carbonate into bicarbonate.

These reactions are essentially time reactions, and the necessary plant which legislates for such reactions must be designed in accordance with the conditions established by the operation of a pilot plant.

Relatively concentrated CO_2 can be obtained by the removal of H_2S from the waste gases arising from an ammonium sulphate plant, where gas liquor is the source of the ammonia supply. Usually, such gases contain 20 to 30

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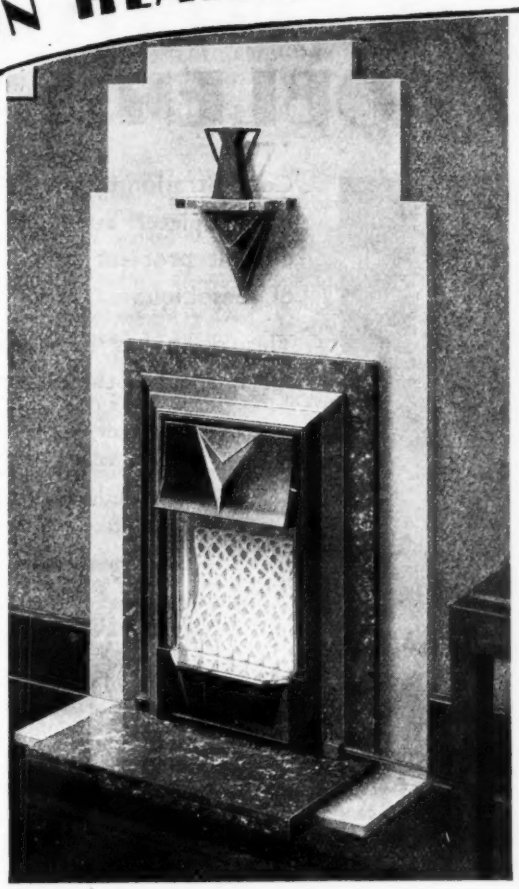

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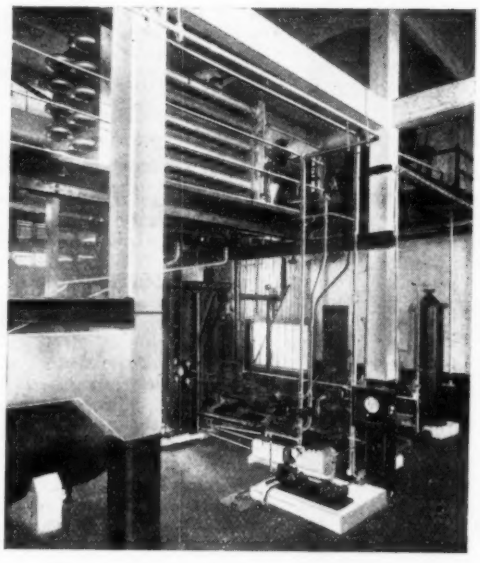

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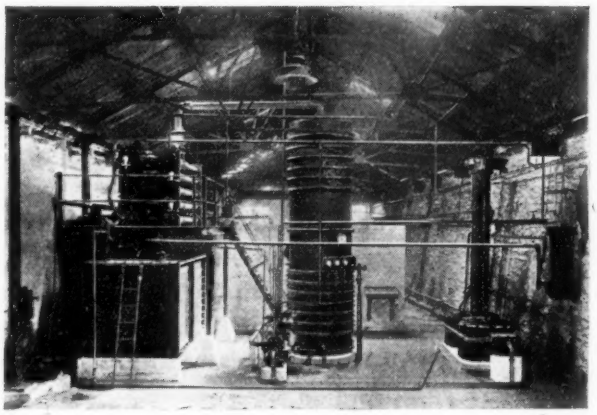

Thorncliffe-Baldurie Plant at Devonport—
Capacity 60 tons of Liquor per day.

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per cent. H_2S, and 78 to 68 per cent. CO_2, with air, pyridine, and traces of hydrocyanic acid as impurities.

Such gases, after cooling, can be passed to oxide of iron purifiers for the absorption of hydrogen sulphide, and the resulting CO_2 can be collected in a gasholder, used largely for pressure-governing purposes, for supply to the carbonating apparatus.

In the absence of the above source of supply of CO_2, a producer can be used, designed to gasify coke, and to produce CO_2. The gases from such a producer will need to be washed for the elimination of SO_2 and dust prior to their passage to the carbonator. Such special producers can now be obtained ensuring a CO_2 concentration in the gases of 16-18 per cent.

Where CO_2 is obtained by the gasification of coke, it will be appreciated that because of the larger volume of gas used, more ammonia is likely to be carried from the carbonator to the final gas liquor scrubber and, therefore, the size of that vessel will need to be designed according to the source of the CO_2 and its concentration.

The unit processes entailed in the manufacture of ammonium bicarbonate by the process under discussion are: (1) carbonation, (2) crystallization, (3) centrifuging, (4) distillation of the ammonium bicarbonate mother liquor, (5) drying, and (6) absorption of the H_2S and ammonia carried by the gases leaving the carbonator.

Carbonation and Crystallization.

The average composition of concentrated gas liquor available for conversion to ammonium bicarbonate should be of the following order:—

NH_3	16 per cent	by weight
CO_2	20 ,,	,,
H_2S	1 ,,	,,

As commercial ammonium bicarbonate contains about 21·5 per cent. of ammonia and about 55·7 per cent. carbon dioxide, it will be appreciated that

$$\frac{21{\cdot}5}{16} \times \frac{100}{95} \text{ (efficiency of process)}$$

= 1·415 tons of concentrated gas liquor of the above composition will be required per ton of ammonium bicarbonate manufactured.

Moreover, assuming it is necessary to use, as practical experience suggests, an excess of CO_2 or CO_2-containing gases to the extent of 20 per cent. above theoretical, in the carbonating process, it can be computed that approximately 8 cwt. of added CO_2 will be required per ton of ammonium bicarbonate manufactured from concentrated gas liquor of the given composition.

The reactions indicated above continue until the concentrated gas liquor becomes saturated with ammonium bicarbonate. The process of formation is gradual, and as crystallization is promoted by the presence of a solid in a crystallizable liquid, the tendency is for the crystals to form on any convenient surface, unless suitable provision is made to avoid this.

In the "Parrish" form of carbonator-crystallizer, the first and second unit processes are legislated for and occur more or less simultaneously. Moreover, the temperature conditions can be controlled by cooling externally.

The carbonator-crystallizer is a multi-compartment vessel, provided with a shaft, on which are keyed small spoon-shaped distributors, revolving at such a speed as to create a fine spray inside each compartment. Intimate contact is obtained between the CO_2, or CO_2-containing gases, and the concentrated gas liquor.

Further, the operation of the spoon-shaped distributors is such as to maintain the newly formed crystals in suspension, so as to admit of their growth.

At pre-determined intervals, the magma can be discharged to the magma-collecting tanks, and its discharge is facilitated by the inclined bottom with which the carbonator-crystallizer is provided.

The solubility of ammonium bicarbonate at a temperature of 20° C. is approximately 15 per cent. by weight, from which it can be computed that 85 per cent. of the ammonia of the original concentrated gas liquor can be recovered as a crystalline ammonium bicarbonate, if the necessary temperature conditions are maintained and the crystals are supported in the mother liquor from which they alone grow.

Concentrated gas liquor undergoing ammonium bicarbonate formation and saturation must have an adequate time contact in the carbonator-crystallizer, so as to ensure the attainment of equilibrium conditions, which is a slow process.

By using the carbonator-crystallizer in accordance with known conditions, already largely defined, it is possible to produce a stable crystalline product having the following size characteristics:—

Passing 30-mesh screen	80	per cent.
Passing 50-mesh screen	55	,,
Passing 80-mesh screen	10	,,

Centrifuging.

The magma is discharged from the magma-collecting tanks direct to the centrifuge, and the mother liquor is pumped to a storage tank. The crystals are centrifuged for about five minutes and then discharged from the centrifugal and fed at a pre-determined rate to the dryer, about which more is given below.

Distillation of Mother Liquor.

The mother liquor is diluted with the gas liquor which is used in circulation in the scrubber on the outlet of the carbonator-crystallizer, until a pre-determined concentration of ammonia has been reached. This is the most practicable and economic method of arresting the entrained ammonia. Such mixed liquor, in the "Parrish" process, is distilled in an automatically-operated still, which allows of distillation being effected with a minimum of steam and provides for the condensed hot liquor, containing the ammonium bicarbonate in crystallizable form, being discharged direct to the carbonator-crystallizer.

In this way, avoidance of crystallization in the preheater tubes is ensured.

Drying.

In view of the high dissociation pressure of ammonium bicarbonate, it is advisable to dry the crystallized product at a temperature of about 20° C. For this purpose it is necessary to remove the natural humidity of air and effect the drying at practically atmospheric temperature.

Air can be dried by refrigeration, adsorption, or absorption.

Refrigeration may occasion difficulty, because, in drying by this means to low humidities, the formation of ice occurs on the ammonia or carbon dioxide cooling coils. This necessitates arresting the process to admit of the removal of the ice.

Certain porous solids possess a great affinity for water vapour, because of the intense capillarity of the prodigious number of ultra-microscopic pores. For example, silica gel will take up 20 to 30 per cent. of its own weight of water and still appear dry.

Sulphuric acid, glycerine, or a solution of calcium chloride can be used for removing the humidity of air by absorption. At a centrally-situated chemical works one can use either sulphuric acid or calcium chloride solution to advantage for the purpose in question.

The best type of dryer is one of the rotary type, designed for simultaneous showering and propulsion of the crystals to be dried, and employing dry air obtained by the passage of air through a lead-lined tower, suitably packed, and irrigated with either 96 per cent. sulphuric acid or calcium chloride solution.

It may be desirable to screen the dried ammonium bicarbonate crystals in order to remove dust—that is, the material passing an 80-mesh screen.

If a rotary screen is used for this purpose, and the fines are redissolved in mother liquor and recrystallized, a more attractive product—less susceptible to volatilization—is obtained.

Absorption.

It is appreciated, from what has already been remarked, that the CO_2 or CO_2-containing gases used for carbonating the concentrated gas liquor will carry with them traces of ammonia, and the best method of arresting such ammonia is to circulate gas liquor through a tower scrubber of suitable size.

The concentration of free ammonia in such gas liquor should not be allowed to exceed, say, 3 per cent. The scrubber should be provided with an external cooling coil, so that the temperature of the circulated gas liquor, and hence its vapour pressure, can be controlled. The gas liquor which is removed from the circuit from time to time is mixed with mother liquor and undergoes distillation in the manner previously described.

The hydrogen sulphide emerging from the scrubber is passed through a hydraulic change valve to oxide of iron heap purifiers, which are used alternately.

Economics of Manufacture.

Enough has been said concerning the technique of the process under review to allow one to judge of its merits and value. What is now vitally important in connection

with the manufacture of a relatively new product, such as ammonium bicarbonate, to be used as a fertilizer is:—

(*a*) to estimate the capital cost of an economic unit of plant,

(*b*) to arrive at a figure which represents the cost of manufacture,

(*c*) to examine what will be the effect of its production on other gas works by-products and other fertilizers, and

(*d*) to form some idea of what would be involved in its sale and distribution.

(*a*) An economic unit of plant for the manufacture of ammonium bicarbonate from by-product ammonia—concentrated gas liquor—has already been defined as one capable of manufacturing 7,500 tons annually.

It is estimated that the cost of such a plant will be of the order given in Table A.

TABLE A.—*Estimated Capital Cost of Economic Unit of Plant.*

	£
1. Producer and purification plant for the provision of the necessary CO_2-containing gases	1,000
2. Carbonators, with their motors for driving, transmission gearing scrubber tower arranged for gas liquor circulation, and all appurtenances	1,600
3. Crystallizing and mother liquor tanks	600
4. Self-contained centrifugal, with staging and all equipment	1,000
5. Dryer, elevator, conveyors to store, and transmission gearing	1,600
6. Automatic distilling apparatus, with controls and preheater for treating the mother liquor, &c.	600
7. Foundations for plant and building	600
8. Building for the accommodation of the ammonium bicarbonate plant, and store for storing 3,000 tons of ammonium bicarbonate	3,500
ESTIMATED CAPITAL COST	£10,500

(*b*) As regards the cost of manufacture, the following cost sheet is based on the production of 7,500 tons of ammonium bicarbonate annually, or say 30 tons per day, for 250 days of the year.

It has to be remembered that the manufacture of coal gas is seasonal, and concentrated gas liquor is not available in uniform quantities throughout the twelve months of the year. The rate of delivery in winter months may be thirty to forty per cent. greater than in summer months.

Any plant for the manufacture of ammonium bicarbonate must have adequate capacity to deal with peak-load deliveries.

Although Table B is called a cost sheet, it must be emphasized that it is essentially a forecast of the cost of production, made in the light of semi-technical experience of the said method, in relation to other cognate processes. It is a forecast which, in the writer's view, will be realized in practice.

The successful conduct of any business to-day depends on planning ahead, and on the adoption of budgetary control, which may be said to be "a highly-developed method of co-ordinated working to a plan of estimates, based on the fullest information available, interlocking these estimates into a budget, and regularly checking-up results against quotas set." Equally, in connection with the consideration of any new process, the same necessity exists for combining experience with judgment of facts and of integrating such experience and judgment to secure the highest degree of accuracy. This is what has been attempted in the so-called cost sheet.

If the central chemical works had available waste gases from boiler settings or producers, or waste gases, arising from a sulphate of ammonia plant, containing CO_2, it is estimated that the cost of production of ammonium bicarbonate would be reduced by at least 3s. per ton, or 1·7d. per unit.

TABLE B.—*Cost Sheet, Based on Annual Production of 7,500 Tons of Ammonium Bicarbonate.*

	Per Day.		Per-centage.
	£ s. d.	£ s. d.	
1. Raw materials—			
(*a*) CO_2 containing gases (16 to 18 per cent CO_2)—			
3·6 tons of mixed coke and breeze, in equal proportions, at 16s. per ton	2 17 7		
1 man per shift; that is, 3 men per day, at 11s. per shift	1 13 0		
Repairs and maintenance	0 7 6		
Water for cooling	0 8 0		
Supervision	0 5 0		
		5 11 1	5·9
(*b*) Concentrated gas liquor, based on a conversion efficiency of 95 per cent.—			
42·45 tons, containing 16 per cent ammonia by weight; price for concentrated gas liquor, 1s. 3d. per unit of ammonia at 16 per cent. = 20s. per ton.			
42·45 tons at 20s.		42 9 0	45·3
		£48 0 1	51·2
	Per Ton of Product.		Per-centage.
	£ s. d.		
Daily production = 30 tons / £48 0s. 1d.	1 12 0		51·2
2. Labour—4 men per shift of 8 hours = 12 men per day, at 11s. per shift 132s. / 30 tons	0 4 3		6·7
3. Supervision	0 2 6		4·0
4. Steam for the distillation of the mother liquor and gas liquor collected in the process and for other subsidiary purposes	0 3 6		5·6
5. Power—60 h.p. at ½d. per h.p.-h. = 2s. 6d. × 24 hr. / 30 tons	0 2 0		3·2
6. Repairs and maintenance—Materials and labour	0 6 6		10·4
7. Sulphuric acid—say	0 1 0		1·6
8. Cooling water	0 1 6		2·4
9. Rent, rates, insurance, taxes, and lighting	0 3 6		5·6
10. Interest on capital—5 per cent. on £10,500 = £525 / Yearly production, 7,500 tons	0 1 5		2·4
11. Depreciation at 7½ per cent. on £10,500	0 2 1½		3·4
12. Contingent expenses	0 2 2½		3·5
COST PER TON OF AMMONIUM BICARBONATE, CONTAINING 21·5 PER CENT. AMMONIA BY WEIGHT, NET NAKED AT WORKS	£3 2 6		100·0

(*c*) From the viewpoint of the Gas Industry, an ideal fertilizer would be one which necessitated the use not only of by-product ammonia, but the whole of the sulphur produced in the form of spent oxide. Such chemical fertilizers can be produced, in granular form, and it is known that they possess many advantages.

Under present-day conditions in this country, about 5 lb. of free ammonia and 12 lb. of sulphur are produced per ton of coal carbonized. If, therefore, ammonium bicarbonate is to be manufactured by a central chemical works for the Gas Industry, it will be appreciated that a market must be found for spent oxide.

Much of the spent oxide produced at gas works to-day is sold for the manufacture of sulphate of ammonia, produced either from gas liquor or concentrated gas liquor. Smaller quantities are used in the production of calcium superphosphate.

If ammonium bicarbonate is to be manufactured on any substantial scale, it is certain that a difficult position will be created in the matter of the disposal of spent oxide. Examples of what such a condition involves exist and represent experiences during the last twelve months. One works, carbonizing 50,000 tons of coal per annum, was manufacturing sulphate of ammonia at a loss. But it was realizing, for its spent oxide, 6d. per unit, because there was a dual arrangement for the purchase of spent oxide and the sale of sulphuric acid required in the manufacture of such sulphate of ammonia.

The moment the gas undertaking ceased to manufacture sulphate of ammonia (in other words, discontinued the use of sulphuric acid) the unit-price of sulphur of the spent oxide was reduced to 3d.; thus incurring a loss of 3d. per unit. In other words, the reduced realization was equivalent to at least 7s. 6d. per ton of sulphate of ammonia.

It cannot be doubted that a similar fate, perhaps not so drastic, awaits those undertakings which seek either directly or through some central chemical works to combine their by-product ammonia with some acid other than sulphuric acid.

If by-product ammonia is manufactured and sold as a fertilizer it must displace other fertilizers, such as sulphate of ammonia, unless, of course, there is a general improvement in the demand for nitrogenous fertilizers. The ultimate effect would be that ammonium bicarbonate would be sold in competition with sulphate of ammonia. What this means, and what the sale and distribution of ammonium bicarbonate will entail, is a matter for immediate and careful consideration.

(*d*) Ammonium bicarbonate will not prove as flexible in use as ammonium sulphate, because it cannot be employed for the preparation of compound fertilizers without causing reversion of calcium superphosphate.

Its sale, in the nature of things, must be effected through the existing selling organization—the British Sulphate of Ammonia Federation—and it is hardly likely to command

a better price than the average of the net home and export prices, which during the last two years has been of the order of 4s. per unit of ammonia.

The disparity between the unit price of ammonia paid by farmers and that realized by gas undertakings generally is a matter of concern, and calls for more detailed examination than is possible here.

It is not imagined that much expense will be incurred in propaganda in fostering sales of ammonium bicarbonate. Many farmers will make the experiment of using ammonium bicarbonate in replacement of sulphate of ammonia, provided they have the assurance of the Rothamsted people that the results of the employment of the new fertilizer will be substantially the same as accompany the use of sulphate of ammonia.

Ammonium bicarbonate may need to be packed in Calcutta twill bags, with a waterproof paper lining, and such bags will be rather more expensive than those normally employed for carrying sulphate. The position, therefore, regarding the manufacture of ammonium bicarbonate, on what may be regarded as an economic scale, is as follows:—

	Per Unit of Ammonia.	
	s.	d.
(*a*) Manufacturing expenses (see page 480) .	2	10·8
(*b*) Estimated sales expenses	1	3·2
	4	2

If no better price can be realized for the ammonia unit than has been indicated above, then it is clear that the central chemical works cannot pay more than, say, 1s. per unit of ammonia for concentrated gas liquor, delivered to the central chemical works.

It may, of course, be possible in certain areas to dispose of spent oxide no less favourably than exists at the present time. If this is the case, then it would appear that a price for concentrated gas liquor of 1s. 3d. per unit of ammonia can be paid, delivered to the central chemical works, and the operations of the latter, as regards ammonium bicarbonate manufacture, can be conducted without loss.

It is felt, however, that other chemical fertilizers can be produced to better economic advantage than ammonium bicarbonate, although it cannot be doubted, from a general survey of this contribution, that the manufacture of ammonium bicarbonate, in certain areas and under certain special circumstances, possesses distinct potentialities which justify further exploration.

Finally, it is desired to emphasize that the views expressed in this contribution are those of the writer, and are not necessarily shared by the Liquor Effluents and Ammonia Committee of the Institution or the Company with which the writer is connected.

Introduction.

Mr. CHARLES F. BOTLEY: I do not propose to introduce the Report, as that will be done by Dr. Key, but I should like to make a few comments. I claim that the Report represents a year of very useful and interesting work, and I feel that some of the investigations have reached a stage when we can speak with authority on various problems concerning effluent disposal and ammonium questions, and with an authority such as we could never have ventured to act upon prior to these investigations. I think also I can claim that as the result of the work which is being done, although apparently it is not recognized by all members of the Industry, that there is less tendency now to rush for the destruction of ammoniacal liquor, and more care is taken in considering methods of disposal. Where sulphate of ammonia is not a practical or economic proposition, concentration plant offers, as has been pointed out many times, great possibilities. In this connection we shall have an Institution test at Coventry on a new concentrating plant, by the courtesy of Mr. Langford and his Committee, and that will give us very detailed information on various points. I would also just like to call the attention of the members, although we are not advocating the production of ammonium bicarbonate in preference to sulphate, to the interesting amended process of Dr. Key, which certainly offers possibilities and is comparatively simple.

One other point I wish to mention is on the suggestion of the Committee, and it is that we do get a number of inquiries, and it is a great pleasure and privilege to be able to deal with them. Very often, however, we hear nothing more, having given advice. It is something like going to the doctor or physician and getting a prescription and going home and taking the prescription or not as you like. If it does you any good you forget all about the doctor until his bill comes in, but the Committee does not send in a bill; they would like, however, to know the result of the advice which has been given to any member, and perhaps if there are any here—or outside, by the assistance of the Press—who have been unmindful of that obligation, perhaps they will be good enough to remember it in future.

Only one other point, and that is, I should like to take this opportunity of expressing my thanks and obligations to all those who have been associated with me in this particular work. It is a great pleasure to have such a spirit of co-operation and to have such officers and research chemists serving the Committee.

(Dr. A. KEY then introduced the Report.)

Discussion.

Professor J. W. COBB: I think that all I want to say briefly has been dealt with at greater length and in more detail, and no doubt more effectively, by Dr. Key, so that it is unnecessary for me to say anything about the contents of the Report. The reason that I have come to the rostrum is to say what possibly Dr. Key has not felt himself justified in saying, and that is to remind you that although a considerable amount of the work of the Effluents and Ammonia Committee finds its way into the Report, there is another aspect of the work which is carried out mainly through the Chairman and Dr. Key and his assistants in advice and experiments which are directed towards the solution of special problems raised by individuals, questions on which the Chairman and Dr. Key are consulted. It would be rather unfortunate if that part of the work of the Committee were not pointed out.

Mr. F. R. O'SHAUGHNESSY (Birmingham, Tame, and Rea District Drainage Board): I have in the first place to thank you for the invitation which I received from your Secretary to attend this Meeting, and also Dr. Key for his courtesy in asking me to take part in the discussion.

Incidentally, I am much interested in the success of the efforts to dispose of the ammonia in gas-works liquors, for it is on the whole better if this portion of the crude waste liquor be kept out of the sewage. There are several reasons for this. One is that the odour of crude liquor is objectionable, and at times I have known it cause considerable nuisance when discharged to the sewer. Another is that ammonia may retard biological oxidation processes, and Dr. Key's Report furnishes evidence confirming my experience in this respect. A third is the very intriguing fact that if biological purification is carried beyond a certain point so that pronounced oxidation of the ammonia present has set in, then the effluent so discharged to the river, although of a high standard as regards purification, will tend to deplete the dissolved oxygen in the river by reason of the accelerated biological oxidation of the residual ammonia.

It is obvious that the more ammonia contained in the sewage the more pronounced will be these effects to which I have referred; and as the discharge of crude liquor to the sewer may in some cases even double the ammonia present in the resulting sewage, it will be seen how desirable is some alternative method of utilizing the ammonia in gas liquors. Dr. Key has some references to towns, usually near the coast, where untreated sewage is discharged without treatment to open waters. The number of such towns where this disgusting practice of releasing great volumes of foul water in the neighbourhood of beaches which are used for bathing is surprisingly large. Although waste gas liquors would be less objectionable than other materials discharged in this way, the condition of the foreshores at many seaside resorts, and the evidence as to the organic content of sea-water in the neighbourhood of the littoral indicates the undesirable and even dangerous results which accrue from the discharge of highly fermentable materials to open waters.

The elaborate and careful attention which Dr. Key and his colleagues have bestowed on the remarkable biochemical reactions which take place with fixed nitrogen calls for very high commendation, as these phenomena are of great practical importance in sewage works practice.

The ease with which much of the material in waste gas liquor undergoes aerobic fermentation is a phenomenon of outstanding importance, and we are greatly indebted to Dr. Key for the care with which he has demonstrated the facts in this regard. It should not be overlooked however that while this phenomenon may have its advantages, it may lead to, and actually does cause, embarrassment on large scale activated sludge plants. What impresses me immensely is the determination of this Committee to leave nothing undone in their search for methods of solving this problem of the proper disposal of the waste liquors coming from gas-works; and The Institution of Gas Engineers is to be congratulated on the work of this enterprising body. The care and thoroughness with which the whole of the work is being done and the manifest enthusiasm of your Research Chemist, Dr. Key, call for the generous appreciation of people like myself who are interested generally in the disposal of waste materials. The large scale tests at Leamington on the one hand and the investigation of

economic disposal of products such as ammonia by the Committee and by Mr. Parrish on the other show the large minded manner in which the Institution is tackling this matter.

May I reiterate my conviction that this work furnishes a classical example of the way in which an industry should deal with waste material arising during the course of manufacturing operations.

Effluent Troubles at Leamington.

Mr. R. S. RAMSDEN (Leamington Priors Gas Company): In his opening remarks Mr. Botley referred to the help which his Committee has given to gas undertakings in the difficulties which may have arisen in connection with the disposal of effluents from sulphate of ammonia plants, and I should like to take this opportunity publicly of acknowledging the very great help which the Leamington Priors Gas Company has received from this Committee and its officers, and also from His Majesty's Inspectors of Alkali Works in dealing with the problem that arose at Leamington in the winter of 1928-29. You may remember that that was a very severe winter and we were changing over from manufacturing gas in horizontal retorts to vertical retorts at almost the same time that the new sewage works at Leamington were put into operation. I know they got into very serious difficulties at the sewage works, but whether or not there was any connection between that and our change over from horizontal to vertical retorts, I am not prepared to give an opinion. The Committee, however, was a great help to us and to the Corporation in getting out of these difficulties, and I now tender my thanks most heartily to the Committee for that help. The thought came into my mind that possibly the research work of Dr. Key during this summer at Leamington was carried out there on account of those troubles of mine in 1929 and the way they were overcome, but I have been wondering since whether there was not another reason and that there was not perhaps something else in the charm of Leamington Spa as a place to conduct that kind of work because of the opportunities that exist there of recuperating from the ardours of this work in the Pump Rooms and Gardens afterwards!

Dr. A. PARKER: I did not really intend to take part in this discussion at all because as a Member of the Committee I have discussed these matters many times before at the various Committee meetings, but I should like to add, as I think I have said at several meetings, that other people outside the Industry do greatly appreciate the work which Dr. Key has carried out with such remarkable thoroughness. Mr. O'Shaughnessy has just referred to the value of the work to those directly interested in sewage disposal and in the operation of sewage works. I might say also that the Water Pollution Research Board, with which I happen to be connected, has followed this work throughout and have followed it so closely that they have included a short account of the Institution's experiments in every one of their Annual Reports for the last five or six years.

As to the present Report, Dr. Key has shown that under certain conditions gas works effluent when discharged into the sewers can be satisfactorily purified in admixture with sewage at the sewage disposal works, although he has at the same time stressed that it may leave what he terms a residual material still capable of absorbing oxygen. This does throw, I think, some additional burden on the sewage works, and for this reason I think the gas works should still do everything possible to cut down the volume of effluent for disposal by adopting the methods previously recommended, methods of modifying the scheme of condensation of tar and liquor. The gas works should still, I think, take every step to bring down the liquor as free from the higher tar acids as possible by breaking down the tar before condensing the liquor. At the same time the volume of liquor should be kept to a minimum.

Then comes the question of ammonia recovery to which attention has already been drawn by Mr. O'Shaughnessy. This I am glad to see is moving in a better direction. More works are recovering ammonia for the production of concentrated liquor and for the production of sulphate. Another example of the appreciation of the work of Dr. Key by those outside the Industry is that he has already had an invitation from other Institutions to give Papers, to the Sewage Works Managers and similar organizations, and within the next fortnight he is to give another Paper on the same subject before the Royal Sanitary Institute which is holding a Congress at Leamington. After the Meeting the visitors are being given the opportunity of inspecting the Leamington sewage disposal works on which some of the large scale experiments have been carried out.

Dr. KEY: I do not think there is much to reply to, but there is one thing I should like to say. It is rather peculiar that the expression of thanks which has been given by Mr. Ramsden should come from the very person I forgot myself to thank in my introduction. I should have said how very indebted the Committee, and myself in particular, are to Mr. Ramsden for his co-operation in the test which we have carried out this summer. I should like to say that it was very nice working at Leamington Spa, and that at the Spa there is no more pleasant place than the sewage works. Although some of you do not appreciate that, apparently, you will do if you happen to visit Leamington Spa sewage works. I went to Leamington first of all because conditions there were so very favourable in the sense that arrangements could easily be made for a strictly comparative test to be carried out and, secondly, because we got such willing co-operation from Mr. Ramsden and his staff and also from the Corporation officials. We are very much indebted to them. I do not know that any of the points raised by Mr. O'Shaughnessy and Dr. Parker call for any detailed reply here.

26th Report of the Refractory Materials Joint Committee

The Refractoriness-Under-Load Test.—Refractory materials in use are frequently subjected to both temperature and mechanical stress. The gas industry has long recognized the importance of a test giving information on the stability of a refractory material under the combined action of stress and high temperature. The refractoriness-under-load test, as described in the Standard Specifications for Refractory Materials for Gas Works, Publication No. 94 of The Institution of Gas Engineers (Note II, page 21), requires greater definition before it can be put forward as a standard test. In last year's report, a full discussion of our knowledge of the test, together with associated data, was presented. Experiments, in which representative refractory materials were used, to ascertain (*a*) the effect of varying the rate of rise of temperature of the test-piece, (*b*) the effect of varying the area of cross-section of the test-piece, and (*c*) the effect of the material (carborundum) supporting the test-piece in the furnace, were also reported. Continuing with these investigations the effect of the height of the test-piece has now been defined. The study of these variables makes it very evident that if comparable data are to be obtained from tests carried out by different workers, then it is essential that definite standards of practice must be formulated.

There is a variant of the under-load test which indicates the stability of a specimen of refractory material on heating to and maintaining at a given temperature for a given time under a stated load. The standard specification adopted in the United States of America requires a procedure on these lines. This test, if adequately conceived, can serve a very useful purpose. An extensive series of experiments covering the principle of this test have been carried out, and are described in the Report.

The Action of Alkali Vapours on Refractory Materials.—The durability of refractory materials in many high-temperature installations is affected by the actions of gases and vapours as well as by slags and slag-forming substances in the solid and liquid states. The destructive action of the vapours from the compounds of alkali metals is of particular interest.

In both the 24th and the 25th Reports of the Refractory Materials Joint Sub-Committee, studies of different aspects of the general problem, including (*a*) a statement of the present position of research, (*b*) the action of vapours from molten potash at 900° and 1,000° C. on firebricks and silica bricks, (*c*) the action of potassium chloride vapour on refractory materials at 1,000°, and (*d*) a comparison of the rates of volatilization from alkali-impregnated firebricks and silica bricks at 1,000° and 1,100° C., have received attention.

In this Report another series of experiments concerned with the reactions of the vapour of potassium chloride at 1,000° on these materials, under both dry and moist conditions, is given in detail. These investigations reveal striking differences in behaviour between silica and fireclay

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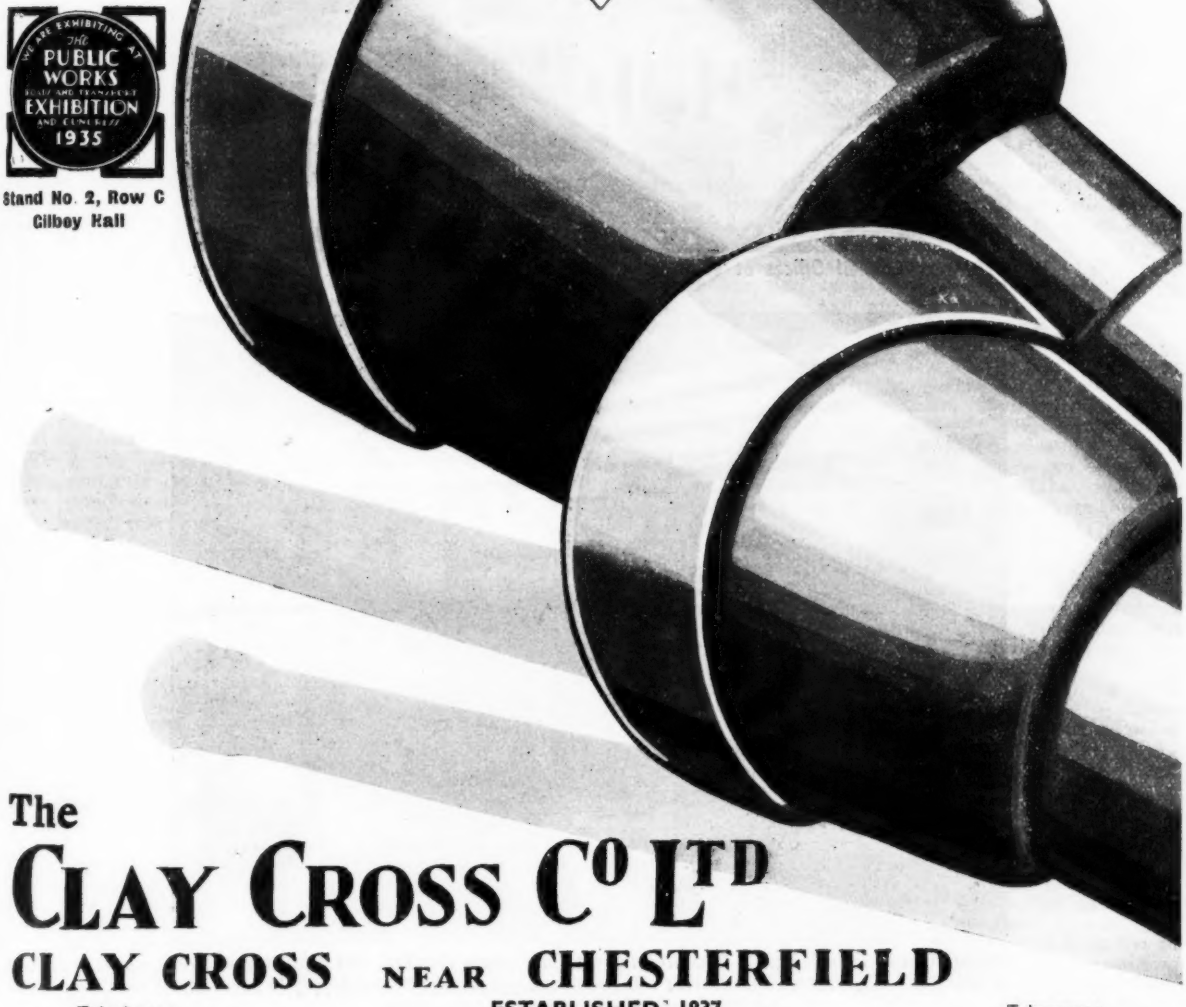

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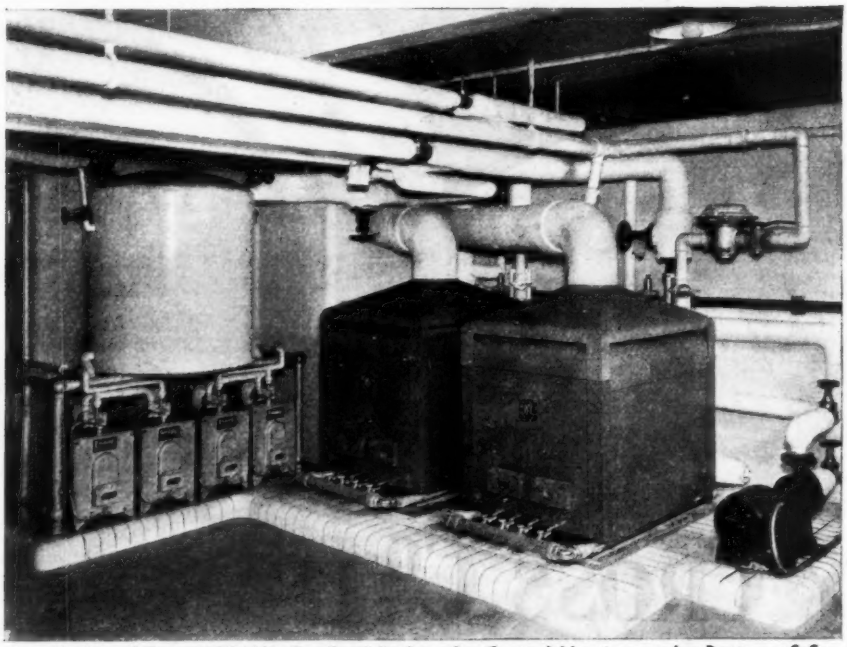

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products. During the year the action of the vapour from a potash-silica glass at 1,200° has also been included in the programme.

The Effect of Hydrocarbon Gases on Refractory Materials.—In earlier reports, comprehensive laboratory investigations on the effect of carbon monoxide in causing the disintegration of typical firebricks, mainly at temperatures in the vicinity of 500° C., have been described. As the result of this work, the mechanism of the actions causing disintegration have been defined. Methods by which the effects of such actions can be reduced have been put forward.

In addition to the disintegrating action of carbon monoxide, there is definite evidence—some of which comes from the study of firebricks in carbonizing units—which points to the fact that hydrocarbons can disrupt firebricks. Investigations on this problem have been commenced. In one series of experiments, it has been observed that methane, on being passed at a slow velocity over test-pieces cut from certain firebricks maintained at 800° C., caused complete disintegration. This breakdown is associated with the deposition of carbon, and, further—as in the case of the action of carbon monoxide—the "iron spots" are concerned in the action. These researches clearly show that gases which can react with one or more of the constituents in the body of a refractory product, may, in consequence of this reaction, so weaken the structure of the product as to cause its eventual breakdown.

Experiments on the Behaviour of Sillimanite Mixes on being Pressed.—During the past four years a number of researches have been conducted by the British Refractories Research Association and presented to the Institution, with the object of elucidating the factors influencing the texture of refractory materials, and, thus, of giving more precise definition to the term "texture." The relation between texture and durability is very evident. The investigations on the permeability of refractory materials to gases, reported in the 23rd and 24th Reports of the Joint Sub-Committee, indicated the extent of the research necessary in this field. One of the important factors influencing texture is the process of pressing, by which bricks and blocks are given their shape. For the past two years (25th and 26th Reports of the Joint Sub-Committee) the attention of the Association has been chiefly directed to the behaviour of granular and almost non-plastic materials, as typified by sillimanite mixes containing small percentages of clay and of water.

For some industrial operations refractory materials are required to be of low porosity. A study has, therefore, been made of the extent to which this can be achieved by the application of high pressures. It is evident, since the porosity decreases in a logarithmic manner as the pressure increases, that the rate of reduction of porosity with increasing pressure will be very small at high pressures. The application of very high pressures may not be an economical proposition, at least, from this standpoint. Again, certain conditions of pressing blocks may result in the production of a product, which, from the outset, has a texture varying from the exterior to the interior. Again, the depth of the material in the mould has a marked effect on the density of the product. The reported investigations have been concerned with evaluating these effects for mixes of different constitution as regards size of grain, and containing different proportions of clay. During the progress of the work it has been discovered that other alterations in texture—as distinct from the consolidation effected—attributable to the process of pressing are produced. This is due to the degradation in the size of the grains and consequent alteration in the proportions of the different sizes present.

Jointing Cements.—The section on jointing cements, in continuation of investigations reported in the 25th Report of the Joint Sub-Committee, describes experiments which have been conducted on the properties of some cements of application in the laying of firebricks. The expansion-contraction characteristics of a number of synthetic cement mixtures, on heating to and maintaining at temperatures of 1,100° and 1,300° C., have been obtained. The effects of additions of bentonite, fireclay, and sodium silicate to crushed sillimanite, crushed firebrick, and a crushed calcined clay are detailed. Measurements of the relative strengths at ordinary temperatures produced by the addition of different cold setting agents to ground ganister are reported.

Other Researches.—The study of high-porosity silica bricks has been continued. An attempt has been made to produce a material with a porosity of over 65 per cent., and a reasonable mechanical strength at high temperatures, by the inclusion of anthracite, coke, or graphite in the original mix. The products possessed little mechanical strength. Further work is required to establish the best content of flux, and the best conditions of firing of these more porous materials. The work on high-porosity silica bricks is being supplemented by similar experiments using sillimanite and other calcined refractory materials as a basis.

A section of the Report deals with the production of silica bricks of high tridymite content. A silica brick containing high proportions of tridymite is reputed to have a lower reversible thermal expansion and a higher refractoriness-under-load value than a normal silica product containing the higher proportion of cristobalite. From the observations made in this work it appears that the presence of lime in a silica brick favours the conversion of the quartz to cristobalite, whilst the presence of "iron" brings about an increase in the conversion to tridymite. Excess "iron" tends to mask the lime effect, but does not overcome it completely.

Reference is made to two Papers which have appeared in the Bulletins of the B.R.R.A. "The Reversible Thermal Expansion of Refractory Materials" reviews the present knowledge concerning this property for a wide range of materials. "Research and Refractory Materials" is an account of the research work on the technology of refractory materials and cognate subjects published during the last few years.

A progress report of other work, not ready for publication but of interest to Gas Engineers, and a list of Papers of indirect interest, which have appeared in recent Bulletins of the B.R.R.A., are included.

NOTES ON THE TEXTURE OF REFRACTORIES.

(1) Non-Regularity of Texture of Gas Works Fireclay Refractories and Its Possible Effect on Durability.

By T. F. E. Rhead,[1] M.Sc., F.I.C., and R. E. Jefferson, M.Sc., A.I.C. (Central Laboratories, City of Birmingham Gas Department).

In 1934, when the Refractory Materials Joint Sub-Committee of The Institution of Gas Engineers, the Society of British Gas Industries, and The British Refractories Research Association revised the Standard Specifications for Refractory Materials for Gas Works, it was felt that on the question of texture it was inadvisable to specify more than that "the material shall be . . . of uniform texture." The Joint Sub-Committee took this stand owing to the uncertainty prevailing as to how far irregularity of texture adversely affects the durability of refractories under working conditions. It was thus left to the common sense judgment of the purchaser and maker as to what degree of regularity might be necessary.

While this action was justifiable at the time, it has, nevertheless, left both purchaser and maker in a very difficult position—one which needs clarifying as soon as possible.

During many years' experience with refractories, the authors have examined numerous deliveries from several makers containing refractories of very irregular texture, and have often found great difficulty in deciding whether to pass or fail such material on texture. Their difficulties have been chiefly with fireclay refractories.

It has been their practice, before coming to a decision concerning any doubtful delivery, to take into account, when possible, the position in the setting where the material is to be used; and they have then considered how far its irregular texture would be likely to affect adversely its life under the working conditions met with in that position. They have also tried to relate the effect of irregular texture to such examples of deterioration as they have met with when examining old settings during dismantling.

It is hoped that the following remarks on some of their experiences will further stimulate discussion on this very important subject, and will be looked upon as being in some degree complementary to the valuable fundamental work of the British Refractories Research Association on the subject of texture.

Case 1. *Laminated Texture.*

Refractories possessing a decidedly laminated texture, the laminations proceeding in straight or curved directions, are frequently met with. Such laminations may arise from several causes and appear to affect the properties of the brick in varying degrees according to the agency which produces them.

If such laminations extend in a direction from the working surface towards the interior of the brickwork when built into the setting, they must greatly facilitate the penetration of slag and deleterious vapours and gases into the body of the refractory, especially when the protective outer layer has worn off. Again, such laminations will quickly close up if the material reaches the neighbourhood

[1] This Paper, with 25 diagrams, appeared in the Transactions of the Ceramic Society, August, 1935.

of 1,100° C., at which temperature fireclay is plastic under load, giving an exaggerated form of contraction. For example, if, in 13 ft. of brickwork, each 3-in. brick has cavities totalling only $\frac{1}{16}$ in., it could settle $\frac{1}{2}$ in. by the simple closing up of such cavities.

When the laminations run more or less parallel to the working face, any tendency to flaking or peeling away of the face of the refractory must be considerably augmented by such planes of weakness.

Again, such planes of weakness must greatly facilitate the loss of material when cracks develop perpendicular to the surface, such as those caused by deep crazing.

When the laminations are curved and run across corners, they must augment any action which tends to remove corners and edges, such as the action of abrasion, corrosion, and thermal strain.

Case 2.

Laminations and cavities of a conical shape are frequently produced in bricks made by the machine pressing of stiff plastic slabs. The excess of material forced through the dies apparently flows from the more plastic centre of the slab and produces a considerable disturbance, which seriously affects the texture of the brick.

It is reasonable to surmise that when these bricks are built into certain positions in the setting, such texture is an undesirable feature. It tends to give the brick smaller dimensions in the middle, and the load is thus distributed round the edges; further, the radiating cracks are at such angles as to weaken considerably the brick and to facilitate the penetration of undesirable compounds into the interior.

Case 3.

Another peculiar type of texture comes about by the trail of fine clay left by the screw when a grogged clay mixture is extruded from the mill during manufacture. The concentration of fine clay in the centre of the brick gives different properties to different portions of the brick, leading to uneven drying and burning shrinkage, with consequent cracks and distortion. These in turn lead to weakness in use and facilitate penetration of undesirable compounds.

In conclusion, the authors urge that much more attention be given to the problem of texture. They are not, however, unmindful of the practical difficulties of manufacture, and would point out the many stages in the course of manufacture during which irregular texture may be imparted to the refractory, viz.:—

(*a*) Air incorporated as flattened blebs during pugging, and giving a laminated effect.
(*b*) Grain or laminated effect produced by the dragging action of the pug mill blade on the grog.
(*c*) Variation in moisture content of clay fed to the pug mill.
(*d*) Action of extrusion from extrusion press.
(*e*) Trail of fine clay particles left in the centre of extruded mass from screw of extrusion press.
(*f*) Filling of moulds by kneading in successive lumps of plastic mix, causing squelching of previously added material.
(*g*) Escape of excess material from extrusion holes when pressing bricks from stiff plastic slabs in moulds.
(*h*) Lamination effect of pressure in machine moulding.
(*j*) Cracking during drying.
(*k*) Shrinkage of matrix from grog during drying and firing.

(2) Pictorial Methods of Recording the Texture of Refractories and Similar Materials.

By T. F. E. Rhead, M.Sc., F.I.C., J. N. Shorrock, M.Sc. Tech., A.I.C., and C. L. Evans, A.I.C. (Central Laboratories, City of Birmingham Gas Department).

During the routine of testing refractories to the Standard Specifications for Refractory Materials from Gas Works, Institution Publication No. 94, the texture of the material regularly comes up for discussion, and hence the recording of texture has become a desirable part of the testing programme.

For accurate records expert photographs are undoubtedly the most reliable, though at times these leave much to be desired in the matter of contrast between solids and voids. This fact led the authors to experiment with modified forms of Rose's Coke Structure Method by filling the voids with a material which would give a suitable contrast to the refractory, and would, moreover, allow the specimens to be ground without loss of grog, &c., from the surface.

To obtain good penetration into the finest pores of the specimen, it was desirable to use a material in liquid or colloidal form, which would solidify without contraction and support the structure during grinding and polishing. Materials like plaster of Paris or cement are too coarse-grained, and up to the present the most successful material has been molten wax, coloured black, and forced in under 30 atmospheres pressure of nitrogen. (Note.—Neither air nor oxygen must be used owing to the risk of forming explosive mixtures with the wax vapours in the pressure vessel.)

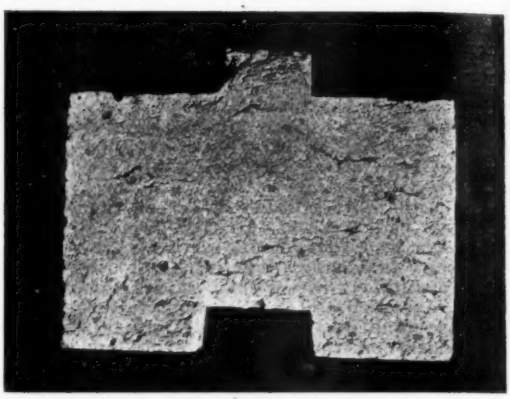

Figure 1.—*Section of Firebrick Flattened on Abrasive Wheel and Finished by Hand on Steel Plate with Abrasive Powder, Showing Flow of Material into the Tongue and Extrusion Effect in the Centre of the Groove.*

The technique is as follows:—A mixture of equal parts of carnaüba and paraffin waxes, coloured black, is melted in the bomb of a fuel calorimeter (which, after removal of platinum tubes, happens to be a suitable pressure vessel). The specimen, cut and roughly ground to a size not greater than 3 in. by $1\frac{1}{2}$ in. by 1 in., is heated to about 200° C., lowered into the wax, and the cover well screwed on. The vessel is kept in a steam bath and exhausted to remove air from the pores of the refractory. Nitrogen is then forced in to a pressure of 30 atmospheres from a cylinder, and this pressure is retained for several minutes.

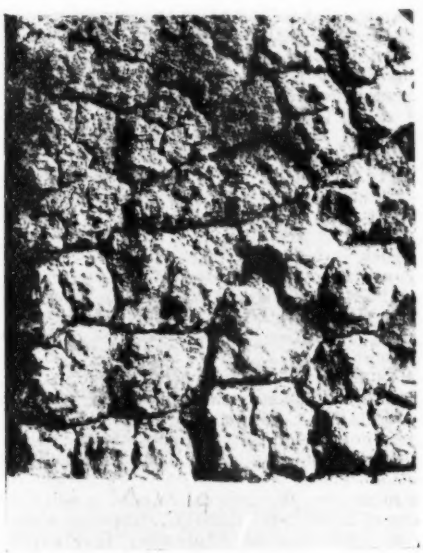

Figure 2.—*Deeply-Crazed Fireclay Brick from Top of a Retort.*

In another method of recording texture, a substitute for photography was adopted by taking an ink impression of the surface by means of a gelatin medium. This method, whilst not so accurate as the photographic method, applies where it is desirable to obtain rapidly a record for general rather than research purposes. It was first used for coke structure records in these Laboratories in 1929. It lends itself admirably to technical uses, and does not require

elaborate apparatus or a high standard of skill, yet gives a speedy, permanent, and easily reproducible result. The technique employed is as follows.

The brick is fractured, if need be, and ground on a suitable abrasive wheel until the required surface is plane. The surface is now inked with printer's ink applied by a

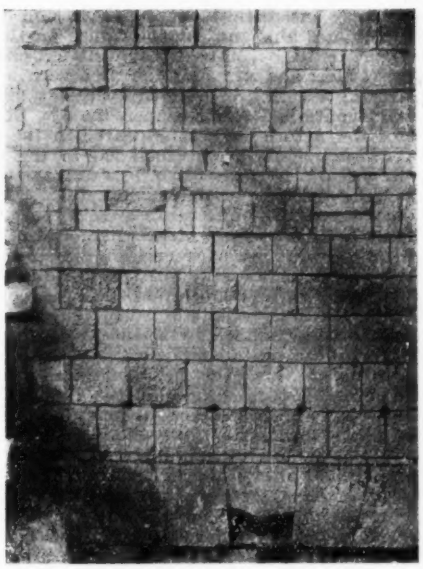

FIGURE 3.—*Lower Portion of Retort Showing Loss of Edges and Corners of Old Design of Seating Block.*

squeegee roller, faced with " roller composition " (a resilient gelatin-glycerine mixture). An impression is then taken on a slab of roller composition (say, ¼ in. thick, cast on a sheet of plate glass surrounded by a wooden frame) by placing the inked surface of the brick in contact with the gelatin slab and applying pressure judiciously.

In this way the gelatin receives an impression of the structure of the brick. A print is taken off the slab by gently pressing on a piece of suitable paper, using a glass stopper or rubber squeegee, and then carefully peeling off immediately. The choice of paper and ink is a matter of experience, and with a little practice good results are obtained. India paper and a type of thin, smooth, mounting card have proved very suitable in conjunction with a good quality, but rather thin, printer's ink.

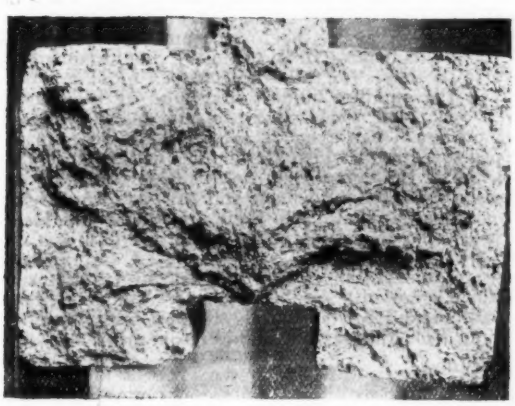

FIGURE 4.—*Section of Fireclay Brick Showing the Effect of Extrusion of the Centre.*

The interpretation of the prints requires a little study. The cracks and cavities obviously appear white, and the high reliefs, which usually indicate the texture, print out black. By more careful grinding on a flat steel plate with fine carborundum—say, F grade—the finer details of texture can be recorded.

In some cases, notably that of silica, owing to the different absorptive capacities of the matrix and the large grains, the former appear as half tones and the latter as full tones. Similarly, iron spots often appear as white areas with black margins, in a matrix of half tones.

Modifications of the above process have been used for obtaining a record more akin to a photographic positive, for example,

(*a*) by using black paper and white ink;

(*b*) by taking the black ink impression on cellophane and then making a bromide print; whilst

(*c*) useful blue print positives can be made by taking the black impression on tracing cloth and then printing.

Many other applications suggest themselves, such as using the process for taking impressions of the texture of refractories in settings. It should be noted, however, that the process records the relief surface only, and hence voids caused by the breaking away of grog, &c., during grinding show up as faulty texture. Provided this exaggeration is

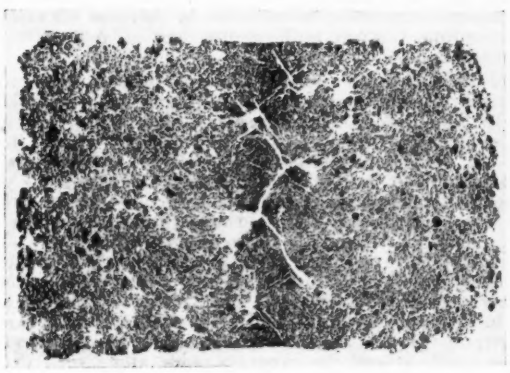

FIGURE 5.—*Section of Firebrick Showing Trail of Clay. (Ink Impression of the Surface by Means of a Gelatin Medium.)*

borne in mind, it often provides a useful emphasis of the quality of texture.

The authors wish to thank the General Manager of the City of Birmingham Gas Department, and the Gas Committee, for permission to publish this information.

Introduction.

Mr. WALTER GROGONO: I do not propose to discuss the Report which is before you as this will be done in a moment or two by the Assistant Director of Research, Mr. Green. There are, however, one or two remarks which I should like to make. As you probably all know, new laboratories were opened at Stoke-on-Trent in 1934. These laboratories are now fully at work and are dealing not only with research but also the testing of refractory material. A meeting of the Refractory Materials Joint Committee was held at the laboratories last June. After the Meeting some of the members were conducted round the building by Mr. Green and personally I was very much impressed with the work which I saw being carried out. A considerable proportion of the work in hand requires original apparatus and all this apparatus is being made by the staff. Although some of the work done at Stoke-on-Trent does not directly concern the Gas Industry, the effect of the whole of the work must be to improve the standard of refractory material. The laboratories at Stoke are very complete but there are still a number of additions required and at the present moment a new furnace room is being built. All this work cannot be done without a considerable amount of money being spent, and, although I know that the Gas Industry has contributed a large share towards the expenditure, I would ask members to encourage the assistance of the undertakings with which they are connected. At the present moment a certain amount is being done to bring pressure to bear on the other industries using refractory materials to increase their contributions to the British Refractories Research Association.

In conclusion, I should like to thank the members of the Refractories Joint Committee of this Institution for the

amount of time they have spent in attending meetings and for their whole-hearted interest in this work.

Mr. A. T. GREEN (Assistant Director of Research, British Refractories Research Association) then introduced the Report.

Discussion.

Mr. T. F. E. RHEAD (Birmingham), who remarked on the great usefulness of the research work carried out at Stoke, said: Among other subjects treated the subject of jointing cements is particularly interesting, especially the application of a load test. This has prompted me in Birmingham to incorporate a load test in the routine testing of jointing cements and it is proving very useful in differentiating between the bonding properties of cements. Engineers will recall that when settings are being dismantled the jointing cement appears to have made a good bond in some places and not in others even where the same temperature conditions have obtained—this difference is most likely due to the greater or less pressures which have obtained at those points occasioned by expansion of the material and the effect of the bracing of the setting.

Mr. Rhead then showed about 18 lantern slides illustrating (1) the texture of refractories, (2) the relationship of texture to the life of refractories in use, and (3) methods of recording texture both photographically and by ink impressions.

Mr. FRANK WEST (Vice-Chairman, British Refractories Research Association): I should like to say on behalf of the British Refractories Research Association and more particularly for the Chairman and myself of that body, that the Report presented in such detail shows that important work and progress has been made during the year. I say that because we two, probably, are more in touch with the investigators than perhaps the other members of the Committee. The main impression gained from a study of this Report is the wide scope of the investigations which are occupying the attention of the refractory materials research staff. The whole of the work has some bearing on the ultimate behaviour of refractories to the carbonizing industry. In all cases the quality of the work carried out is excellent and the progress made along such various avenues of exploration is to be commended.

I should like to make brief reference to finance, but, first of all, I should like to say how much the Association appreciates the financial support that this Institution and the gas undertakings have given to the Research Association and hope, as Mr. Grogono has already mentioned, that they will continue and if possible increase their support in the future because I believe we are really only on the fringe of these examinations and we shall certainly require to spend very much more in our research work in the future.

Speaking as a member of the Institution I should like to make a few remarks on some of the investigations and in the first place to congratulate Mr. Green on the way the Report has been presented. The work on alkali attack is progressing favourably and in such work, although such step by step progress is apparently slow, the results are of fundamental value to the appreciation of certain factors in the life of refractories. New ground has been broken in the study of the action of methane on refractory material. This type of reaction offers a wide field for investigation and gives food for thought to manufacturers on the question of producing refractories capable of resisting such actions. Refractoriness under load has now been thoroughly investigated from numerous angles and the solution of the problem of introducing a standard specification test is being seen more clearly. It is hoped that a standard method of testing will soon be specified in order that assessment of the mechanical strength of refractories may be made from comparative data.

The problem of determining the desirable attributes of jointing cements for various types of refractory materials is still being vigorously attacked and the work done on this in the Report is worthy of careful attention. It must be realized that this question is one of vital importance as the cement must be refractory enough to withstand the temperatures necessary, yet it should vitrify so as to adhere to the brickwork. There must be different cements for different temperatures in the same setting even when the temperature only varies as much as 150° C.

The Texture of Refractories.

The work carried out by Mr. Rhead on texture of refractories is very interesting and valuable and I should like to congratulate him and his colleagues on this work. It considers the texture from a totally different angle from other investigations and provides the user with a method of demonstrating the lack of uniformity of texture in certain types of material. This Paper by Mr. Rhead on "Texture of Refractories" first appeared in the Ceramic Society's Transactions and was included in the Gas Engineering Report owing to its intrinsic value and it should also be of great interest to the manufacturers. I might mention that the manufacturers are alive to this question of texture and are doing a considerable amount of work on it and are trying to get over certain difficulties which probably may be in the manufacture but possibly may not. Some of them we shall no doubt find out in due course.

Mr. GREEN: Obviously there is some truth in the observation as to being blinded by science. Apparently the subject is too diffuse or too difficult for the members to discuss. May I here, however, just make the quip that it does not seem to be too diffuse or too difficult when I happen to place my head inside a gas manufacturer's office for he seems to know much more about them than I do myself. I had to make that quip because I rather felt that we should have had a good discussion from many whom I know are thoroughly interested in the subject. I have nothing more to say except to agree very definitely with the remarks of Mr. Grogono and Mr. West with regard to funds because we might have jam three times a week instead of once if we got more money.

The PRESIDENT: I am sure you would like me to assure the Committee and Mr. Green and his fellow workers who have contributed to this most excellent Report that lack of discussion does not mean lack of appreciation. The Report is, if anything, more valuable than its twenty-five predecessors and I do not think I can assess it higher than that. The advance that has been made in refractories is entirely due to the work carried out by the British Refractories Research Association and by the Joint Refractories Research Committee in collaboration with the Association. That cannot be questioned. The value of it is almost beyond the price. There is no doubt about it that with high temperature carbonization to-day we are getting very good results from silica in spite of the fact that we have not yet discovered the best method of jointing nor have we discovered a jointing material which has the desirable properties of viscosity and elasticity mentioned by Mr. Green. Notwithstanding that, the life of silica segmental retorts to-day is very considerable. There are many of us who have had 2,000 days' satisfactory working from segmental silica retorts, which is 25 per cent. advance on what we had ten years ago, and those of us who are able to base results on practical experience of the actual life of materials express our grateful thanks to the research work that has been done and I do consider that every gas undertaking in the country should contribute its quota to the funds for this research. £1 or £2 is not much even to the smallest undertaking and if the burden is shared by all the work can go on not only as it has been going on but it can even be accelerated. Therefore, I do support the appeal which was made by Mr. Grogono, the Chairman of the Committee, that the representatives of all undertakings should go back and say that this Report is of so great an advantage to them and that the value being obtained from materials being bought to-day was due to work for which they are not paying—I am referring of course to undertakings who are not direct subscribers—that their companies should subscribe. I hope in that way you will make up your minds to pay for what you are receiving from this very valuable research.

Report on Air Vitiation and Gas Appliances

By C. A. MASTERMAN, M.A., M.I.Mech.E., F.I.C., E. W. B. DUNNING, B.Sc., A.I.C., and A. B. DENSHAM, M.A.

AIR VITIATION AND GAS APPLIANCES.

I. Perception by Smell of the Products of Combustion.

A sufficient concentration of the products of combustion is perceptible as a pungent smell characteristic of the oxides of sulphur. This smell is distinct from the sooty smell of incomplete combustion which should never be present, and which is probably in part due to the presence of aldehydes.

Sense of smell varies among individuals and with the circumstances of exposure, an observer in a gradually increasing concentration remaining quite unaware of a contamination which is markedly objectionable to an individual coming in from the fresh air. The technical literature referring to minimum perceptible concentrations of sulphur oxides is therefore conflicting and states various values for sulphur dioxide upwards of 0·00015 per cent. and for sulphur trioxide upwards of 0·00002 per cent. Tests have been carried out with 11 observers introduced abruptly into contaminated air with substantial confirmation, in these conditions, of the lowest limits referred to above. The limits for the various definite and possible components in the products of combustion are summarized in Table 1.

Table 1.—*Physiological Effects of Products of Combustion.*

—	—	Permissible.	Objectionable	Dangerous.
1	2	3	4	5
Approximately proportional to gas rate.	CO_2 Carbon dioxide, per cent.	2	3	6
	SO_2 Sulphur dioxide, per cent.	0·0002	0·0005	0·002
	SO_3 Sulphur trioxide, per cent.	0·00002	0·0001	0·0005
	NO_2 Nitrogen peroxide, per cent.	0·001	0·004	0·01
Dependent on appliance.	CO Carbon monoxide, per cent.	0·01	0·02	0·1
	CH_2O Formaldehyde, per cent.	..	0·002	..

The presence of nitrogen oxides is likely to be physiologically unimportant, but may accelerate the oxidation of sulphur dioxide to sulphur trioxide. The proportion of sulphur dioxide to sulphur trioxide in the products of combustion is shown to be an uncertain ratio of about 4:1, suggesting a maximum permissible concentration of the mixed oxides of about 0·00007 per cent. For practical purposes this limit may be considered extreme as it is that below which an observer entering from the fresh air and keenly on the alert for a smell is quite unable to perceive any air contamination whatever. Concentrations up to 0·00001 per cent. would normally not be appreciable and may be considered quite permissible.

By calculation this concentration of sulphur oxides would correspond on a 30 grain sulphur per 100 cu.ft. gas to a CO_2 concentration of 0·1 per cent. Perception of smell or cause for complaint arising from such a low concentration of products does not correspond to normal experience, a partial explanation lying in the absorption of a portion of the sulphur oxides by the distemper and whitewash surfaces in the room. Some of the normal room furnishings will also be basic in character. Tests have confirmed that in various rooms 60-100 per cent. of the sulphur oxides are absorbed and thus fail to contaminate the atmosphere, an average figure being about 75 per cent. Even assuming only 50 per cent. of the sulphur oxides are absorbed an effective air concentration of 0·0001 per cent. sulphur oxides will therefore for average conditions be obtained with a carbon dioxide concentration of 0·2 per cent. on 30 grain sulphur gas.

For town gas of any normal sulphur content the first sensory indication of the presence in the air of the products of combustion will be the smell of sulphur oxides (excluding discomfort from overheating and changed humidity). Practical limits below which no possible disadvantage on this score can arise are shown in Table 2, in terms of corresponding carbon dioxide concentrations.

Table 2.

Sulphur Content of Gas per 100 Cu.Ft.	Sulphur Perceptibility Limit in Terms of CO_2.
1	2
30 grains	0·2 per cent.
20 ,,	0·3 ,,
10 ,,	0·6 ,,
5 ,,	1·2 ,,

Table 2 indicates higher concentrations of carbon dioxide without smell of sulphur oxides than were obtained by Haldane, but these are amply confirmed by tests carried out with flueless gas appliances.

II. Effect of Vitiated Air on Combustion.

When gas is burnt in a closed chamber the oxygen of the air is used up and the carbon dioxide concentration

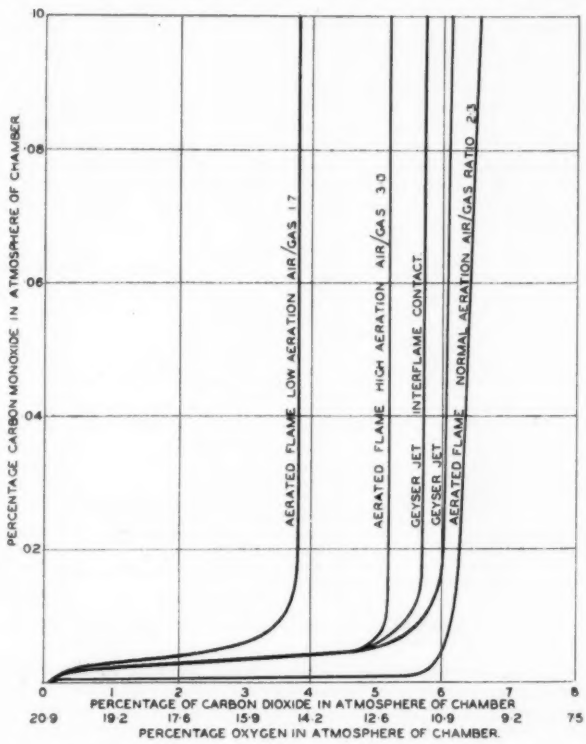
PERCENTAGE CARBON MONOXIDE IN ATMOSPHERE OF CHAMBER
10
08
06
04
02
AERATED FLAME LOW AERATION AIR/GAS 1·7
AERATED FLAME HIGH AERATION AIR/GAS 3·0
GEYSER JET INTERFLAME CONTACT
GEYSER JET
AERATED FLAME NORMAL AERATION AIR/GAS RATIO 2·3
0 1 2 3 4 5 6 7 8
PERCENTAGE OF CARBON DIOXIDE IN ATMOSPHERE OF CHAMBER
20·9 19·2 17·6 15·9 14·2 12·6 10·9 9·2 7·5
PERCENTAGE OXYGEN IN ATMOSPHERE OF CHAMBER.

Figure 1.—*Effect of Vitiated Atmosphere on Free Burning Flames.*

increases. In reaching out for sufficient oxygen the flame size increases while the flame temperature decreases. This variation in size of flame has been used to measure the degree of vitiation in rooms. The inner cone of an aerated flame disappears and the flame becomes progressively more flabby, losing definition especially at the tip until after lengthening to four or five times its normal size the flame is finally extinguished. A luminous flame enlarges to about four times its original area, the colour varying between white and blue until the flame is extinguished. Provided flame contact is absent combustion may be complete up to the point when it ceases altogether, even though the oxygen concentration is then far from sufficient to support the combustion of candles, matches, &c.

Figure 1 shows the effects of extreme vitiation of air on free burning flames having sufficient head room to avoid flame contact taking place however considerably they may lengthen upwards. The fact that the flames are extinguished at between 4 per cent. and 7 per cent. carbon dioxide may appear inconsistent with the behaviour of such a typical gas appliance as the geyser where combustion is satisfactorily completed in an atmosphere contain-

ing more than 10 per cent. carbon dioxide. The cases are, however, not comparable in that in vitiated air the initial stages of combustion take place in the adverse atmosphere which becomes progressively more and more deficient in oxygen as the upper portions of the flames are reached, the critical deficiency at the base probably corresponding to complete absence of oxygen at the flame tip.

The experimental procedure consisted in operating the particular appliance under review in an enclosed space at normal gas rate until insufficient oxygen remained to support combustion. A continuous record was taken over this period of the concentrations of carbon dioxide and carbon monoxide in the enclosed space. Such a procedure would tend to mask any intermittent production of carbon monoxide, and was only adopted after confirming by preliminary trials that normal combustion is maintained until some critical concentration of carbon dioxide is reached after which the carbon monoxide concentration rapidly increases.

On appliances of unsatisfactory design or operating at excessive gas rate appreciable carbon monoxide production may be found in the initial stages of air vitiation, gradually increasing until the flame is extinguished at a low degree of air vitiation. The information which has been sought for this report, however, is concerned with typical satisfactory gas appliances installed and working under normal conditions except for the abnormal degrees of air vitiation in which they have been required to operate.

It has been shown by the United States Bureau of Standards that the maximum safe rate is reduced when operating at high altitudes by 3-4 per cent. of the rate at sea level for each 1,000 ft. of elevation. The mass of air required for combustion will occupy a larger volume at these low pressures and consequently the volume of gases traversing both the air inlets and flueways of the appliance would need to be considerably greater to maintain the same performance. The effect of altitude is therefore similar to that of vitiation in producing an increase in the volume of secondary air and flue gases for the same combustion reaction.

In general it is found that the ill results upon combustion of any defect, whether in design or operation, will be exaggerated if the air of the room becomes highly vitiated. The effect on combustion of air vitiation has been referred to in several American and Continental papers. Brumbaugh derives as maximum safe concentrations about 2 per cent. carbon dioxide, 4½ per cent. carbon dioxide, and 6½ per cent. carbon dioxide from samples of boiling burners, radiators, and ovens respectively. Frei as a result of tests on a number of geysers states that the carbon monoxide production remained low until a room concentration of 1·5 per cent. to 2 per cent. carbon dioxide was reached, after which the carbon monoxide rapidly increased. These critical concentrations are consistent with those obtained by the present authors on appliances of British design.

III. Air Change in Normal Rooms.

The degree of normal ventilation through a room is affected by a number of factors, such as external wind conditions, temperature effects, building construction, and size of room.

Although excessive ventilation can easily be reduced, a further diminution of ventilation to very low limits becomes increasingly difficult. Even if there were no wind or temperature differences to cause air movement, diffusion would take place, while it is impossible to construct a hermetically sealed normal room.

Sensory impressions are an extremely unreliable guide to the ventilation which, if well arranged, can be entirely adequate yet quite imperceptible in the absence of local draught. The least perceptible general draught in a short passage or corridor corresponds to over 1,000 air changes per hour.

Conscious misuse by occupants, such as blocking of air bricks or flues, pasting up windows, &c., will substantially decrease the ventilation, but for normal rooms in normal occupation and in mild weather conditions Table 3 represents a fair summary of the results.

Table 3.—*Air Change* in Normal Rooms.*

Air Brick or Flue.	Doors and Windows.	Heating.	Air Change. Small Rooms Under 1,000 Cu.Ft. Capacity.		Normal Rooms 1,000–2,000 Cu.Ft. Capacity.		Large Rooms Over 2,000 Cu.Ft. Capacity.	
			Flue.	Air Brick.	Flue.	Air Brick.	Flue.	Air Brick
1	2	3	4	5	6	7	8	9
Open	Shut	None	2-3	2	2	1½	1½	¾
Sealed	Shut	None	1	1	¾	¾	½	½
Open	Closed outside door, slightly open window, or other large crack	None	3-4	3	3	2	2	1-2
Open	Door shut, window wide open	None	20	20	10	10	7	7
Open	Both open wide	None	30	30	20	20	10	10
Open	Shut	Flueless appliances	2-3	2	2-3	1½	2	¾
Open	Shut	Coal or gas fires in 9 in × 9 in. flues	5-6	..	4-5	..	4	..

* Note.—One air change per hour indicates that a volume of air equal to the volume of the room had passed out of the room during one hour

A normal result of air vitiation is an increase in the size of the outer envelope of luminous and aerated flames. This will be aggravated in the latter case by a decrease of aeration due to both the increased density and the lower oxygen content of the vitiated air. This increase in flame size may lead to flame contact. The effect of vitiated air will vary according to the type of appliance.

These results may be summarized in convenient form as follows:—

1 per cent. CO_2 (19·2 per cent. O_2). Slight lengthening of flames. Defective appliances may be seriously affected.

1—2 per cent. CO_2 (19·2-17·6 per cent. O_2). Boiling burners especially and other appliances involving cold flame contact, or gas fires with broken radiants may be affected.

(2 per cent. CO_2. Human respiration shows slightly deeper breathing.)

3 per cent. CO_2 (15·9 per cent. O_2). Gas fires, lighting burners and other appliances involving hot flame contact may become affected. Also geysers having inadequate overload margin.

Candles and matches will not burn.

4 per cent. CO_2 (14·3 per cent. O_2). Geysers and other appliances having restricted air supply may become affected.

(Human respiration shows panting and possible discomfort from headache.)

5-6 per cent. CO_2 (12·6-10·9 per cent. O_2). Free burning flames (*e.g.*, oven or radiator) may become affected.

(Human respiration shows marked panting and discomfort.)

Precise information as to the effects of wind on room ventilation is lacking and is probably beyond the possibility of general analysis. High winds may lead to substantial increase above the values in the tables, but much lower values on account of external air stagnation are improbable.

Table 3 indicates that an average air change of 2 is obtained in unheated rooms used for domestic purposes when the doors and windows are shut. Small rooms tend to have more air changes owing to the relative increase in wall surface, but this is counteracted by the fact that small rooms—especially in present-day building construction, are often fitted without flues. Conversely, in larger rooms (over 1,000 cu.ft. capacity) without flues, air changes of less than 2 are to be expected. The excessively small room of 200 cu.ft. capacity or less represents a special case in that it is extremely unlikely to be in use for prolonged periods without the door being opened. The door practically corresponds to the whole side of the room which, with the open door, in effect becomes one with the adjacent room or corridor.

In normal rooms the natural ventilation is reduced by one-half by closing fire registers or sealing air bricks. Varnished wall-paper, painted walls, wood panelling, and heavy curtains all tend to reduce the ventilation as do double windows.

The opening of doors and windows greatly increases the air change and even a small crack or slight opening of a window increases the air change by one-half. This explains the increased air change obtained in rooms, generally kitchens, which have an outside door.

The heating of the room does not materially increase

the ventilation unless a flue is present. If the heating is by flueless appliances the air change increases by one-third, while the provision under a flue of a lighted coal or gas fire more than doubles the air change. Special gas fire flues, owing to their small cross-sectional area, need special care in construction to prevent this area becoming unduly restricted especially at joints and bends. Such restrictions are responsible for the smaller air change reported than would be predicted from the nominal internal size of the flues.

IV. Conclusions.

There are two possible methods for deriving the permissible limit of air vitiation by the products of gas combustion. The theorist will determine the compromising factors and will derive limiting conditions from first principles. The realist will analyze and summarize the conditions as they exist in practice in relation to the satisfaction or complaint expressed by the consumer. The latter method presents a great difficulty in that the standards of comfort and sensitivity vary so widely among individuals. One consumer will exist and rejoice in conditions of air vitiation which to another are not only objectionable but intolerable. The more sensitive individual may sometimes thus acquire a prejudice which even entirely satisfactory conditions may fail to appease. The prestige of the Gas Industry suffers greatly from the survival in use of obsolete appliances of doubtful merit when new and in every sense disreputable after 20 or 30 years of service.

On a statistical basis hazard to health or life from the products of gas combustion is found to be extremely remote*; experience and theory confirm that such few accidents as do occur are due to recognizable cause in ill design or subsequent misuse of the appliances.

If exceptional circumstances caused the products of combustion to reach the high concentration of 2 per cent. CO_2 it would *per se* have little direct physiological effect even if the combustion was in minor degree sub-normal (*e.g.*, broken gas fire radiants), but it might begin to prejudice the combustion of the appliance itself and so lead to excessive carbon monoxide production.

Though room concentrations of products of combustion substantially above 1 per cent. CO_2 will not be prejudicial to safety it does not follow they are desirable from the comfort point of view especially where the sulphur content of the town gas is relatively high. Contamination of the atmosphere appreciable as an unpleasant smell is inconsistent with the first-class performance with which it is possible and desirable to associate gas as a fuel.

An important function of flue equipment is to remove at least such proportion of the products of gas combustion as to prevent any such appreciable vitiation of the air in the room. Even though no flue is used on the appliance, no appreciable vitiation of air will occur if the gas consumption is appropriate to the degree of ventilation of the room.

Owing to wide variations in construction and sizes of rooms, of the habits of the occupants, and of the external wind conditions, any generalization on the normal ventilation of rooms must be used with considerable discretion. With care it is possible so to seal up a room as to allow less than ¼ air change per hour in the absence of wind. In a general survey, however, it is found that in small rooms any air change of less than 1 per hour may be considered exceptional and a more normal figure is about 2 air changes per hour. In larger rooms, the degree of ventilation as expressed by air change is usually less than in small rooms. Ventilation is, of course, increased by the opening of windows, by ill-fitting doors, &c., and notably by the presence of a vertical flue having a gas, coal, or other fire at the base.

On the basis of a maximum permissible sulphur oxide concentration of 0·0001 per cent. the corresponding carbon dioxide concentrations for gases of 10, 20, and 30 grains sulphur per 100 cu.ft. will be 0·6, 0·3, and 0·2 per cent. carbon dioxide. From these limits Table 4 is calculated using a dilution formula in the case of intermittently operated appliances and assuming 50 per cent. absorption of the sulphur oxides by the walls, &c., of the room (SO_2/SO_3 not less than 4/1).

Table 4.—*Maximum Gas Rate for Flueless Appliances Without Smell per 1,000 Cu.Ft. Room Capacity, with Corresponding Concentrations* of Combustion Products.*

Sulphur per 100 Cu.Ft. of Gas.	Maximum Period of Operation.	2 Air Changes per Hour.	1 Air Change per Hour.	½ Air Change per Hour.	Sulphur Oxides Assuming 50 per cent. Absorption.	Carbon Dioxide.	Carbon Monoxide. Normal Maximum CO/CO_2 0·002.	Carbon Monoxide. Overload Maximum CO/CO_2 0·01.	Nitric Oxide NO/CO_2 0·001.
1	2	3	4	5	6	7	8		13
		Cu.Ft./Hr.	Cu.Ft./Hr.	Cu.Ft./Hr.	Per Cent.	Per Cent	Per Cent.	Per Cent.	Per Cent.
10 grains	Continuous	24	12	6					
	1 hour	28	19	15					
	30 minutes	38	31	27	0·0001	0·6	0·001	0·006	0·0006
	15 ,,	61	55	50					
	5 ,,	160	150	150					
20 grains	Continuous	12	6	3					
	1 hour	14	9	7					
	30 minutes	19	15	13	0·0001	0·3	0·0006	0·003	0·0003
	15 ,,	30	27	25					
	5 ,,	80	75	75					
30 grains	Continuous	8	4	2					
	1 hour	9	6	5					
	30 minutes	13	10	9	0·0001	0·2	0·0004	0·002	0·0002
	15 ,,	20	18	17					
	5 ,,	53	50	50					

* Note.—These concentrations are less than those now accepted without comment in the general atmosphere under certain conditions.

Note that subsequent to short period operation at the higher gas rates, a period of time must be allowed to elapse for the products to dissipate themselves from the room before the appliance is again used. This minimum standby period for the 2, 1, and ½ air change conditions is about 1 hour, 2 hours, and 4 hours respectively. The shorter the time in which a given amount of gas is burnt the greater will be the resulting concentration of products in the air. Over a prolonged period the maximum amount of gas can be burnt without nuisance if the appliance is in continuous operation at a steady gas rate, representing in the above cases at 1 air change about double the total consumption burning continuously as compared to burning intermittently.

A number of experiments were carried out under practical conditions to test the applicability of Table 4. In 16 tests, when on the average the gas rate was treble and always above the suggested maxima derived in Table 4, 34 observers could smell nothing and 27 observers noticed something, although a third of these were very indefinite. These results show some discrepancies in detail among themselves but confirm in broad outline under searching conditions the conclusions embodied in Table 4.

Continuously burning flueless gas appliances are most frequently of the type used for room heating. For such appliances it is estimated that a gas rate allowance of 10 cu.ft. per hour per 1,000 cu.ft. room capacity provides

* Note.—Fatal accidents from products of gas combustion for England, Wales, and Scotland:

	1932.	1933.
Flueless heaters	4	2
Geysers without flues	4	2
Geysers with flues	6	6

Cf. Report of Registrar General for 1932:

Fatalities due to falling from a ladder	54
,, ,, ,, injury from horse, bull, or cow	58
,, ,, ,, excessive heat	103
,, ,, ,, horse drawn vehicle	138
,, ,, ,, bathing	224
,, ,, ,, falling downstairs	611

adequate heating under normal conditions where the ventilation does not exceed 2 air changes per hour. Adequate general heating, solely by flueless gas appliances on a gas of high sulphur content is therefore irreconcilable with the absence of perceptible smell. Experience confirms the conclusion, however, that the use of flueless gas appliances, alone on low sulphur content gas or as an auxiliary form of heating where the sulphur content is relatively high, is perfectly consistent with satisfactory results.

Where radiant heat can be used to maintain the comfort of the room occupants in contrast to attempting to heat the whole room it is the number and occupation of the occupants and the heat distribution from the appliance which determines the gas rate required. The gas rate may be much less than 10 cu.ft. per hour per 1,000 cu.ft. of room capacity and even on high sulphur content gas may be consistent with Table 4 and absence of smell.

The fear that there may be local high concentrations of products about the room is not confirmed by actual test, the concentration in the room except at floor level remaining nearly constant throughout.

Quick heating up requires a higher gas rate than is necessary for continuous heating, but thermostatic control automatically reduces gas rate when room is sufficiently heated. If this higher gas rate is left in continuous operation discomfort will result both from overheating and smell of sulphur oxides. From both nuisances the occupier of the room can obtain relief by extinguishing or turning down the gas.

Flueless appliances designed for other purposes, such as water heating, cooking, &c., discharge all the products of combustion, but only a part of the heat, into the room; but all the sulphur in the gas may not be present in the products of combustion since part is often held in the appliance as a corrosion product or in solution in the condense water. Even on low sulphur content gas, sulphur smell may become perceptible without overheating of the room. Relief is obtainable only by allowing additional ventilation which may be unwelcome or by sacrificing the job in hand for which the gas appliance is being used. It is, perhaps, especially in relation to these appliances that careful attention must be given to the room size, probable degree of ventilation, &c., before they are installed, if the user is subsequently to feel satisfied. Often there will be not one but several such appliances in the same room (*e.g.*, cooker, sink geyser, wash boiler, gas iron) some at least being in use for brief and not coincident periods. Considerable discretion in the use of the limits shown in Table 4 is then required if the precise degree of air vitiation is to be forecast. A review of the flueless appliances throughout the country would show a substantial proportion of installations to exceed the derived limits where the sulphur content of the gas is high. Such installations endanger, not the user, but the reputation of gas itself.

1st Report of the Joint Lighting Committee;

Investigation of the Factors Affecting the Performance of Gas Street Lamps

(1) Introduction.

Gas Undertakings are frequently asked to tender for Street Lighting installations to comply with the British Standard Specification for Street Lighting, No. 307-1931, the main provisions of which are summarized below.

Table 1 gives (1) the various British Standard Specification Classes of Street Lighting installations, (2) the required illumination expressed in foot candles on the horizontal plane for each Class under rated conditions at the point of minimum illumination on the carriage-way, and (3) the minimum and lowest recommended mounting heights of light sources for each Class.

Table 1.

B.S.S. Class.	Rated Mean Test-Point Illumination on Carriage-Way.	Height of the Luminous Centre of the Light Source Above the Ground.	
		Minimum.	Lowest Recommended.
1	2	3	4
A	2·0 foot candles and upwards	30 ft.	30 ft.
B	1·0 foot candle	25 ,,	27½ ,,
C	0·5 ,,	21 ,,	25 ,,
D	0·2 ,,	18 ,,	21 ,,
E	0·1 ,,	15 ,,	18 ,,
F	0·05 ,,	13 ,,	15 ,,
G	0·02 ,,	13 ,,	13 ,,
H	0·01 ,,	Preferably 13 ft.	13 ,,

Table 2 gives the maximum and recommended spacing-height ratios for each Class.

Table 2.

B.S.S. Class.	Spacing-Height Ratios. Maximum	Recommended.
1	2	3
A	5	Not more than 3
B	6	,, ,, ,, 4
C	8	,, ,, ,, 5
D	9	,, ,, ,, 6
E	10	,, ,, ,, 7
F	12	,, ,, ,, 8
G	12	,, ,, ,, 10
H	12	,, ,, ,, 10

The Specification also provides for testing and other requirements in regard to minimum illumination for each Class under both rated and service conditions. The "rated illumination" is defined as "the illumination which would be produced if all the factors which govern the illumination were at their rated value." The "service illumination" is defined as "the illumination which prevails at any time during the operation of an installation."

Clause 18 of the Specification provides that in service the Authority responsible for the maintenance of the installation shall not allow the mean test-point illuminations in any Class of installation given in Table 1 to fall below 0·5 times the minimum rated mean test-point illuminations specified in Table 1. A Note to the Clause states that "the difference between the values of the rated and the service mean test-point illuminations is necessary in order to allow for the unavoidable variations in the spacing and to provide for decrease of the candle-power of the light sources, variation due to replacements or incorrect adjustment of the light source in the fittings, soiling of glass and reflecting surfaces of the fittings, changes in voltage or gas pressure and other factors which may cause the service illumination to fall below the rated illumination."

British Standard Specifications are all subjected to periodic revision in order that recent advances may be provided for. The Specification for Street Lighting is under revision and the question of the relationship between the rated mean test-point illumination and the service mean test-point illumination has been the subject of much discussion.

The Joint Lighting Committee of The Institution of Gas Engineers consider that the Classification of Street Lighting installations under the British Standard Specification for Street Lighting should be based on minimum *service* and not minimum *rated* mean test-point illumination, and that the Authority responsible for Maintenance should allow sufficient margin of illumination to compensate for the unavoidable variations enumerated in the Note to Clause 18 of the Specification.

The Committee is of opinion that the 50 per cent. depreciation from rated mean test-point illumination allowed by Clause 18 is an unnecessarily large tolerance and that a maximum of 30 per cent. is sufficient under conditions of good Maintenance. The Committee contends that in the interests of good Street Lighting no encouragement should be given to indifferent methods of Maintenance which, with a tolerance of 50 per cent., might prevail. It is believed that these views are held by the Gas Industry as a whole.

In order that The Institution of Gas Engineers might have data to support the contention that a 50 per cent. tolerance is too high, the Joint Lighting Committee carried out Investigations to determine the depreciation in candle-power which occurred with Gas Street Lighting units working under normal conditions. The scheme for the Investigations was prepared by one of the members—Mr. F. C. Smith, Assoc.M.Inst.Gas E., of the Watson House Research Laboratories of the Gas Light and Coke Company—and the actual tests were carried out by Alexander Wright & Company, Limited, which generously undertook the work without charge other than for actual out-of-pocket ex-

penses. The Committee desires to acknowledge the collaboration and valuable help given by the Company through its Managing Director, Mr. J. Weatherall Foreman, and his Staff.

Three separate Investigations, particulars of which are given below, were necessary to obtain the desired data.

(2) Investigation A.

In this Investigation it was endeavoured to assess the depreciation due to each of the following causes:—

(*a*) Soiled glass and reflectors.

(*b*) Dirty burners.

(*c*) Depreciation in light output from the mantles.

A considerable number of Tests of different types of Gas Lamp were made in various parts of London and in certain representative Provincial Towns, with results which generally suggested that serious depreciation of light output does not take place where regular and proper Maintenance is practised.

It was found, however, that the work of cleaning burners and glass, &c., between successive Tests on the same evening, and in relative darkness due to the burners being turned out, produced conditions which were not normal and frequently damaged the mantles.

The Joint Lighting Committee desires to thank those London and Provincial Gas Undertakings which co-operated with the Committee in this preliminary Investigation.

(3) Investigation B.

In this Investigation Tests were made of the total loss of light output, making no special attempt to evaluate the various factors contributing thereto. The Tests were arranged to run over periods far exceeding those usually employed for Maintenance, and with Gas Lamps installed in a place which, while subject to average normal street conditions, could be kept under close supervision and afforded fuller facilities for observations of pressure, consumptions, calorific values, and other useful data.

Four 6-mantle cluster Lamps (without directional reflectors) were installed in Works situated on the outskirts of London, close to a Street where there was heavy and continuous traffic. A considerable volume of heavy traffic passed in and out of the yard in which the Lamps were fitted. The neighbourhood—partly residential and partly industrial—was taken to represent average conditions found in most Towns.

Two sets of Tests were made, the first during the Summer (August and September), and the second during the Winter, with typical November fog, rain, mist, and frost.

In the case of the first (Summer) set of Tests, two of the four Lamps were in action continuously for 1,200 hours, whilst the other two Lamps intermittently covered 600 hours of use, with lighting and extinguishing taking place so as to average 12 hours lighting each day.

The same four Lamps were employed for the second (Winter) set of Tests, two burning continuously for 659 hours, and two intermittently over 417 hours at an average rate of 16 hours per diem.

The Photometer employed for all the Tests was the Simmance Portable Street Photometer with Flicker head. It was calibrated periodically, the standard used being a lamp certified by the National Physical Laboratory.

The results of the Investigation, expressed in percentages, are summarized in Table 3.

Table 3.

Results of Investigation B.

Depreciation.	Summer.		Winter.	
	Continuous 1,200 Hr. Burning.	Intermittent 610 Hr. Burning.	Continuous 600 Hr. Burning.	Intermittent 400 Hr. Burning.
1	2	3	4	5
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Depreciation in light output caused by all factors on the lamps burning as shown	21	27	24	20
Depreciation (included in above) caused by dirty glass and reflectors only .	10	5	15	11

The percentage depreciation due to dirty glass and reflectors was obtained by Tests made of the Lamps at the end of each period after careful cleaning of the glass and reflectors, care being taken to avoid vibration and damage to mantles. It should be noted that no Maintenance was undertaken during the periods, and in no cases were mantles renewed.

The data obtained under these conditions and with the Lamps described, lead definitely to the conclusion that with normal care, regular cleaning and adjustment, the illumination afforded by Gas Street Lamps, properly governed, can be maintained satisfactorily and with less than 25 per cent. drop in the value initially designed. The contention of the Joint Lighting Committee that the Gas Industry can and should work under service conditions with a maximum tolerance of 30 per cent. is confirmed by these results.

By the courtesy of the Gas Light and Coke Company, the Committee is able to furnish in Appendix 1 data and graphs of Street Lighting installations where the provisions of the British Standard Specification have been complied with in actual practice and over long periods. From these "Specimen Records of Examinations for Test Point Illuminations" it will be seen that "service illumination" values have been maintained with a smaller tolerance than 30 per cent. on Lamps with and without directional reflectors.

Other interesting and useful information was obtained from Investigation B.

The Tests of the Gas Lamps used intermittently and without attention covered 27 Winter days with 400 hours of burning, a longer period than would obtain under good Maintenance conditions. The average depreciation due to all factors for the 400 hours intermittent usage was 20 per cent.; that for the worst Lamp was 23 per cent. Of the total depreciation for this period, probably one of the worst periods of the year, that due to dirty glass and reflectors was 11 per cent. The like depreciation over 51 days (610 hours usage) of two Summer months was 5 per cent.

Observations of Gas consumptions and calorific values were made during the Tests, and throughout the period the latter were well within the Statutory obligations of the Gas Undertaking concerned. It is useful to record that the thermal input (that is, the Gas rate) decreased during the Tests, the average drop at the end of 400 hours being about 7 per cent., which accounts for some proportion of the total loss of light. The decrease in B.Th.U's. used indicates that burner nipples require systematic attention, which suggests the selection and adoption of burner sets which can, without damage to mantles, be easily overhauled for the purpose of cleaning. This should be borne in mind by Manufacturers in the general design of burners.

That an appreciable percentage of the loss of illumination is due to burner nipple neglect would seem to show that the soiling of glassware is only partly to blame for decreased light. There may be cases where glass cleaning is taking more time than is necessary. Some Gas Undertakings have already realized this, and have adopted 10 to 14-day, instead of 7-day, cleaning periods, thus materially reducing Maintenance costs.

(4) Investigation C.

This Investigation is concerned with the loss of light output due to depreciation in mantles. It was undertaken at the request of the Joint Lighting Committee by the City of Birmingham Gas Department and under the supervision of Mr. R. G. Marsh, Assoc.M.Inst.Gas E. The Investigation is not yet complete, but it can be stated that No. 1 and No. 2 mantles, the sizes generally employed for Street Lighting purposes, appreciate in lighting value for a short time, and, taking averages, show no serious loss during the greater part of 1,000 hours continuous use.

The Investigation shows that the percentage depreciation in the light output of good mantles during 1,000 burning hours should not exceed 9 per cent. Lower figures can be achieved. In a recently published Public Lighting Report of a large and important City it is stated that the percentage decrease in light output of the gas mantles used was only 7 per cent. over 1,000 burning hours. The average lifetime of the mantles considerably exceeded 1,000 burning hours.

In the British Standard Specification for Street Lighting the mean service test-point illumination is the average value derived from six Lamps and, since all mantles do not fail at the same time and defective mantles are promptly renewed, the average decrease of illumination in Street Lighting due to depreciation in mantles cannot be of great significance. This is confirmed indirectly by the data obtained from Investigation B.

(5) Summary.

The results of the three Investigations may be summarized as follows:—

(1) If the Gas Street Lighting installation has been arranged to satisfy the requirements of any given Class in

the British Standard Specification, the Gas Engineer may confidently state that:—

(*a*) the mean test-point service illumination can be maintained at 70 per cent. of the mean test-point rated illumination, assuming reasonable Maintenance and

(*b*) any greater tolerance than 30 per cent. deprives installations of an advantage which can be legitimately claimed for Gas Street Lighting.

(2) Under normal conditions in Towns partly residential and partly industrial, no great loss of light output will result from cleaning glassware once a fortnight instead of once a week.

(3) Of the small light depreciation which does occur and which is usually attributed to dirty glassware and depreciation of light output from the mantles, an appreciable part is due to soiled injectors. Lamps to be preferred, therefore, are those in which the injectors can be easily removed without removing the mantles from the burners.

(4) The life to be expected from mantles of good quality should not be less than 1,000 burning hours. Depreciation of light output due to mantles should not exceed 9 per cent. after 1,000 burning hours. Mantles are often removed from Lamps and replaced by new mantles when the cause of depreciation lies in the burners or injectors. Recognition of this should ensure saving in the number of mantles used.

(6) General.

Attention is drawn to the First Report of the Street Lighting Committee of The Institution of Gas Engineers,* Communication No. 42, November, 1931, in which it was pointed out that the advantages of Gas Lighting could be easily lost if Street Lamp installations were out of date or inefficiently maintained. As the comparison of existing Gas Lamps is usually with the latest types of Electric Lamp, stress was laid upon the advisability of displacing old-fashioned Gas lanterns by modern ones and of providing the best burner equipment procurable.

The Report advised the use of governors where pressure variation is abnormal and suggested the adoption of automatic lighting and extinguishing methods, which not only appeal to the public but result in definite economies. Clock controllers permit closer approximation to scheduled lighting times and avoid mantle breakage due to the use of torches.

Directional devices with which graduated illumination can be achieved along the street surfaces have definite advantages, and with proper care, the Report stated, do not cause objectionable glare.

The Report referred to the publicity value of and the charges for Street Lighting and indicated it is desirable, in view of the quantity of gas involved and the fact that a considerable proportion is used after midnight, that the gas consumed should be supplied on at least the lowest terms given to consumers.

In emphasizing the necessity for regular and adequate Maintenance, the Report stated that, with such care, illumination results with no greater drop than 25 to 30 per cent. below rated values could be achieved.

The Committee is indebted to the Gas Light and Coke Company for particulars of its Public Lighting Maintenance Scheme, which has been employed for some time and has proved of considerable service. Details of the Scheme are given in Appendix 2.

Attention is directed to the Report on "The Planning of Gas Installations to Conform with the British Standard Specification for Street Lighting,"† by F. C. Smith, Assoc.M.Inst.Gas E., Institution Publication No. 54, August, 1932, in Appendix 3 of which will be found a number of tables indicating, *inter alia*, suitable units and necessary spacing-height ratios to satisfy the requirements of the various Classes of the British Standard Specification for Street Lighting. Since 1932, however, considerable advance has been made in the type of units available and in the design of directional equipment. Consequently the tables should now be regarded as indicative only of the minimum performance to be expected from modern equipment. Units are now available utilizing heat-resisting refractory glassware, and from them increased performance in regard to test-point illumination is to be obtained, whilst new types of directional equipment, dependent on specular reflection from metal and silvered glass reflectors have been introduced.

Attention is further directed to the Interim Report (September, 1935) of the Departmental Committee on Street Lighting appointed by the Minister of Transport with the following terms of reference:—

> "To examine and report what steps could be taken for securing more efficient and uniform street lighting, with particular reference to the convenience and safety of traffic and with due regard to the requirements of residential and shopping areas, and to make recommendations."

Reproduced in Appendix 3 of this 1st Report of the Joint Lighting Committee is a Summary of Conclusions reached by the Departmental Committee, which is intended to emphasize the principal conclusions and should not be read independently of the body of the Interim Report, copies of which can be obtained from H.M. Stationery Office or through any Bookseller.

APPENDIX 1.

SPECIMEN RECORDS OF EXAMINATIONS FOR TEST-POINT ILLUMINATIONS.

The Graphs (Figures 1, 2, and 3) illustrate the satisfactory illumination maintainable by efficient routine methods of Gas Street Lamp Maintenance. The slight variations shown are in some cases due to the irregular spacing of some Lamps owing to their positions being adjusted to suit the junctions of side streets with the main road.

Examinations for Test-Point Illuminations are made on Lamps under routine Maintenance (see Appendix 2) in accordance with the following procedure:—

The illumination at five points between six Lamps is tested every week according to the British Standard Specification for Street Lighting and the average result of the five Tests is recorded on the Graph; the following week the next span of five test-points is tested in the same way, and so on until the whole length of the installation has been covered; the Examination is continued by re-commencing at the starting point, thus obtaining a continuous record of the illumination.

APPENDIX 2.

PUBLIC LIGHTING MAINTENANCE SCHEME.

The Public Lighting Maintenance Scheme outlined herein is based on experience obtained in the lighting of Council Districts containing from 1,000 Lamps upwards and is used for the Installations examined in Appendix 1.

Local conditions may make it impossible or unnecessary for Gas Undertakings to carry out the entire Scheme, but where it is observed the lighting will be maintained to a high standard.

Lighting Survey.

Where there are sufficient Lamps the Attendants should work under a foreman and muster every night ten minutes before the scheduled time for lighting. Each man should have a definite route to survey, which should be made the same way round on five nights and the reverse way round on two nights of the week. This enables the attendant to remedy clock controllers lighting late, which would not be discovered if the route were not reversed.

Bicycles should be used for inspection work. Short, specially made ladders which can be carried on a bicycle, enable attendants simply to remedy defects in Lamps mounted on the short type of column. Where tall columns are used it is advisable, to save time, to have suitable ladders kept at convenient positions. All ladders should be painted white; this prevents accidents at night both to the attendant and to pedestrians, who are enabled to see, even if the lamp is not alight, the obstruction on the footway.

Lamp Cleaning.

Lamps should be cleaned once a fortnight, the cleaning being carried out in the same order as the survey and half of the Lamps being cleaned each week.

Mantle Maintenance.

The renewal of defective mantles should be carried out at the time of cleaning the Lamps and, if necessary, during the lighting survey, in order to ensure every Lamp being in perfect condition each night after lighting.

Burner Cleaning.

It is most important that the burners of all the Lamps should be thoroughly cleaned not less than once in every ten weeks. The order of burner cleaning should follow that of the survey and the Lamp cleaning. The injectors and gauzes should be removed, if possible, and thoroughly cleaned, experience having shown that dirty injectors and

* Trans. Inst. Gas Engr., 1931 32, **81**, 241.

† Trans. Inst. Gas Engr., 1932-33, **82**, 84.

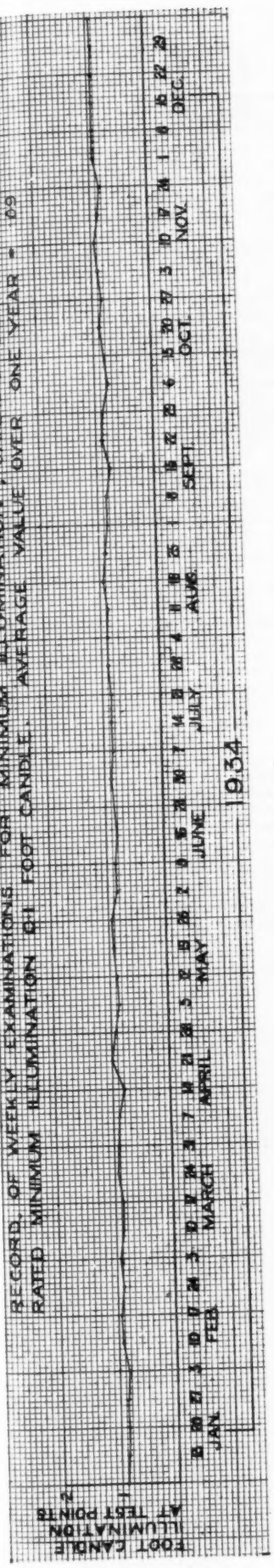
RECORD OF WEEKLY EXAMINATIONS FOR MINIMUM ILLUMINATION, JAN. 1 to DEC. 1934
RATED MINIMUM ILLUMINATION 0·1 FOOT CANDLE. AVERAGE VALUE OVER ONE YEAR = ·09
FOOT CANDLE ILLUMINATION AT TEST POINTS
JAN. FEB. MARCH APRIL MAY JUNE JULY AUG. SEPT OCT. NOV. DEC.
1934

FIGURE 1.

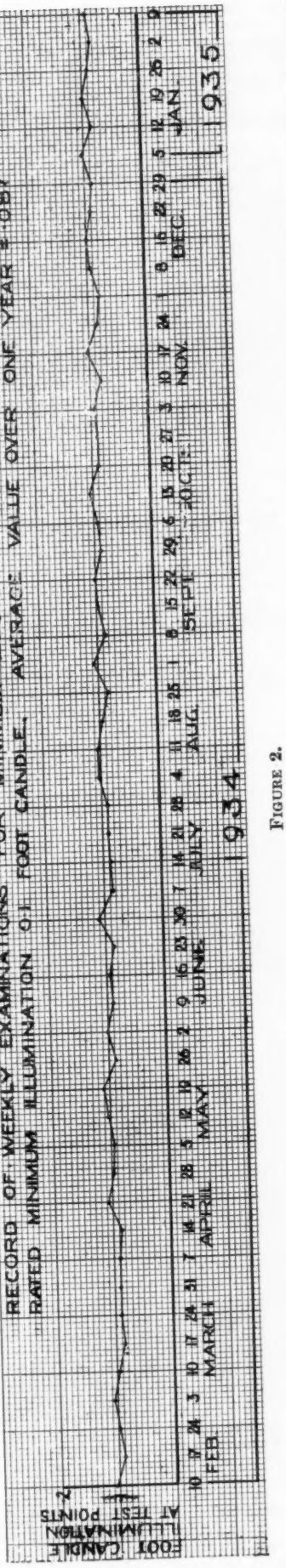
RECORD OF WEEKLY EXAMINATIONS FOR MINIMUM ILLUMINATION · FEB. 1934 TO FEB. 1935.
RATED MINIMUM ILLUMINATION 0·1 FOOT CANDLE. AVERAGE VALUE OVER ONE YEAR = ·087
FOOT CANDLE ILLUMINATION AT TEST POINTS
FEB. MARCH APRIL MAY JUNE JULY AUG. SEPT OCT. NOV. DEC. JAN.
1934
1935

FIGURE 2.

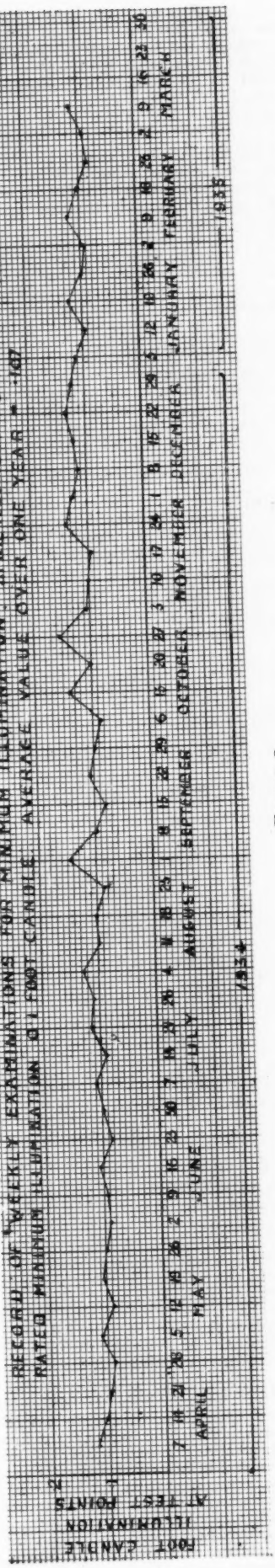
RECORD OF WEEKLY EXAMINATIONS FOR MINIMUM ILLUMINATION APRIL 1934 to MARCH 1935
RATED MINIMUM ILLUMINATION 0·1 FOOT CANDLE AVERAGE VALUE OVER ONE YEAR = ·107
FOOT CANDLE ILLUMINATION AT TEST POINTS
APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH
1934
1935

FIGURE 3.

FIGURES 1, 2, AND 3.—*Specimen Records of Weekly Examinations for Test-Point Illuminations; Figure* 1, *Uxbridge Road, Acton; Figure* 2, *London Road, Southwark; Figure* 3, *Bayswater Road, Paddington. See also Appendix* 1.

gauzes cause more bad lights than any other factor. Owing to the different types of burners, various methods of cleaning must be adopted. It is advisable, however, to have all Lamps made with a plug injector which can be removed for cleaning and replaced with a minimum of trouble.

Clock Controllers.

All Clock Controllers should be capable of working three weeks with one winding. Thus, if the controllers are wound once a fortnight, there is always enough tension on the spring to enable the mechanism to work satisfactorily.

The winding and the setting of the Clocks should be carried out in the same direction as the survey, lamp cleaning and burner cleaning, so that the whole work of maintenance is done by rota and is under complete control.

A common defect in a Clock Controller is for the plug or valve of the gas cock to be too stiff for the spring to turn unless the clock is fully wound up. All plugs should be removed periodically and cleaned, suitable oil or lubricant being applied before replacing them. Some types of Controllers need this attention more than others, but if it is possible, as a matter of routine, to clean and grease every plug once a year, a great improvement in the performance of Clock Controllers will be obtained.

Bypasses.

Careful fixing and accurate adjustment of control devices will ensure the proper functioning of bypasses.

No bypass should be allowed to burn without a fireclay cup giving a non-luminous flame. Carpenter bypass tips must not pass more than one-fifth cubic foot per hour at 4 in. pressure with unrestricted supply. Thus, as shown in the appended Table, it is possible to state approximately the consumption of a bypass by the height of the flame above the top of the cup.

Bypass Consumptions—500 B.Th.U. Gas of Normal Specific Gravity.

Height of Flame Above Top of Carpenter Cup.	Cubic Feet per Hour.
1	2
Flame just level	0·06
$\frac{1}{8}$ in.	0·13
$\frac{1}{4}$,,	0·16
$\frac{3}{8}$,,	0·20
$\frac{1}{2}$,,	0·27
$\frac{5}{8}$,,	0·33
$\frac{3}{4}$,,	0·36

A bypass may be worked without failure with a flame $\frac{3}{8}$ in. above the top of the cup, providing the Lamp is properly glazed and the consumption at this height is one-fifth cubic foot per hour. The standard bypass consumption for a Public Lamp, therefore, should be taken at one-fifth cubic foot per hour.

Extinguishing.

If this Maintenance Scheme is observed, a survey at extinguishing time is unnecessary, provided a good type of Clock Controller is used.

APPENDIX 3.

SUMMARY OF CONCLUSIONS OF THE INTERIM REPORT OF THE DEPARTMENTAL COMMITTEE ON STREET LIGHTING OF THE MINISTRY OF TRANSPORT.

The Interim Report of the Departmental Committee on Street Lighting of the Ministry of Transport (September, 1935) finishes with the Summary of Conclusions quoted below, which is intended to emphasize the principal conclusions reached by the Committee and should not be read independently of the paragraphs in the body of the Report to which reference is made:—

A. *The Lighting of Traffic Routes.*

(1) There should be reasonable uniformity in the lighting of portions of traffic routes (as defined in Paragraph 2) presenting similar characteristics, but minor variations are not necessarily disadvantageous. (Paragraph 9.)

(2) The present system of administration is not conducive to the achievement of uniform and effective lighting on traffic routes. (Paragraph 10.)

(3) Consideration should be given to the responsibility for the lighting of traffic routes being confined to large administrative units (Paragraph 12), and to the suggestion that the cost of lighting roads (as defined for this purpose in Paragraph 12) should be aided by grants from national funds administered by the responsible Government Department. (Paragraphs 11 and 12.)

(4) Adjoining authorities should confer together with the object of securing uniformity of lighting on routes of common interest. (Paragraph 15.)

(5) For traffic routes the minimum standard of lighting should be that which enables drivers to proceed with safety at 30 miles per hour without the use of headlights; on such routes the lighting units should be of at least the number and power of those required for a generously planned Class F of the British Standard Specification. (Paragraph 21.)

(6) There is no existing code of lighting which we can to recommend in all respects for the lighting of traffic routes. (Paragraphs 18 and 19.)

(7) The available light should be so employed as to produce the maximum contrast between the brightness of the object to be viewed and its background, provided there is no undue glare. (Paragraph 22.)

(8) Care should be taken to ensure the adequate lighting of kerbs and footways. (Paragraph 22.)

(9) In general, a mounting height of 25 ft., with 6 ft. overhang, is desirable. (Paragraph 23.)

(10) The positioning of lamps should be studied with a view to securing the best visibility, rather than uniform spacing, but normally the distance between lamps should not exceed 150 ft. (Paragraph 24.)

(11) On bends the lamps should be placed on the outside of the curve; the provision of artificial backgrounds in appropriate cases and of white kerbs at bends should be considered. (Paragraph 24.)

(12) Excessive glare may be largely avoided if care is taken in the selection and use of directive fittings. (Paragraph 25.)

(13) Single-side lighting should be avoided except at bends. (Paragraph 26.)

(14) There should be easy gradation from the standard of lighting adopted for traffic routes to that obtaining in side streets, and at the junction between lighted and unlighted portions of traffic routes. (Paragraph 27.)

(15) Although the selection of road surfacing materials may necessarily be governed primarily by considerations other than those of optical properties, regard should be had, as far as practicable, to reflection characteristics and lightness of colour. (Paragraph 29.)

(16) The trend of design of lighting installations must have regard to the nature of the materials available for road surfacing and surface dressing. (Paragraph 29.)

B. *Miscellaneous.*

(17) Lighting authorities should be advised by an engineer competent to deal with street lighting. (Paragraphs 30 and 31.)

(18) Power to control extraneous lighting should be given to lighting authorities, but only in so far as it may be seriously detrimental to the street lighting. (Paragraph 35.)

(19) Street lighting installations should be complete in themselves and no reliance should be placed on extraneous lighting. (Paragraph 36.)

(20) Authorities contemplating the erection or modification of a street lighting installation in the vicinity of a railway line should notify the railway company beforehand with a view to avoiding possible interference with railway signals. (Paragraph 37.)

Introduction.

Mr. Stephen Lacey (Chairman of the Joint Lighting Committee), introducing the Report, said: I would point out first of all that the Joint Lighting Committee differs in some respects from other Committees reporting to the Research Executive Committee in that it consists of representatives of the national bodies, including representatives of the Society of British Gas Industries.

You will find a short summary of the Joint Lighting Committee's work in the Research Executive's Report. The investigations described in the First Report of the Joint Lighting Committee, which I have the honour to present, were made in connection with that part of the Committee's work dealing with public lighting. It was decided to publish the results of these investigations because it was thought that they should be made available to all gas undertakings responsible for the maintenance of street lamps. By "maintenance" in this connection we mean the work of keeping the illumination at the test points of a gas lighting installation, under actual service conditions, as near as practicable to the rated illumination—when the mantles are new, the glass-ware quite clean, and the burners in perfect adjustment. All will agree that a high standard of maintenance at the mini-

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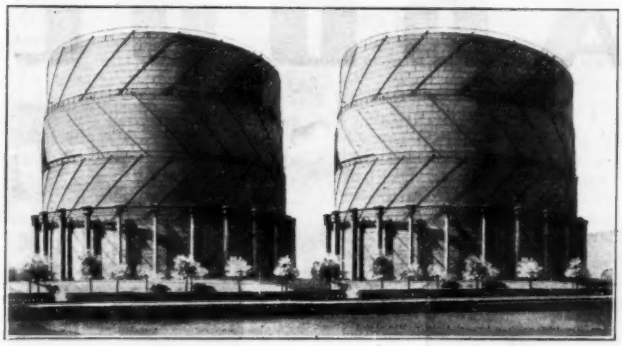

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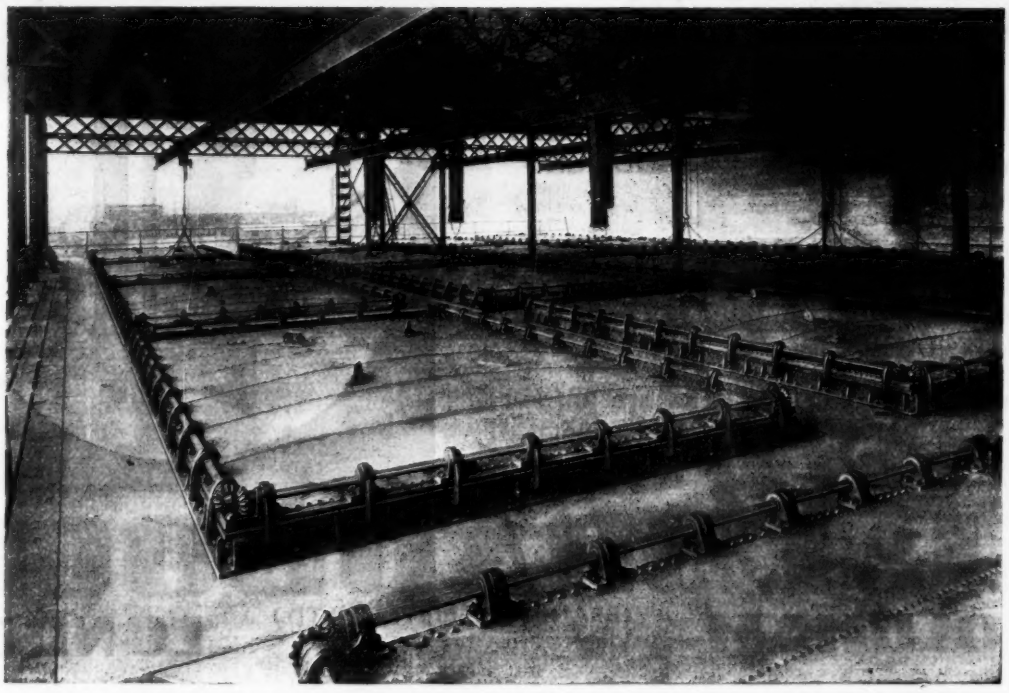

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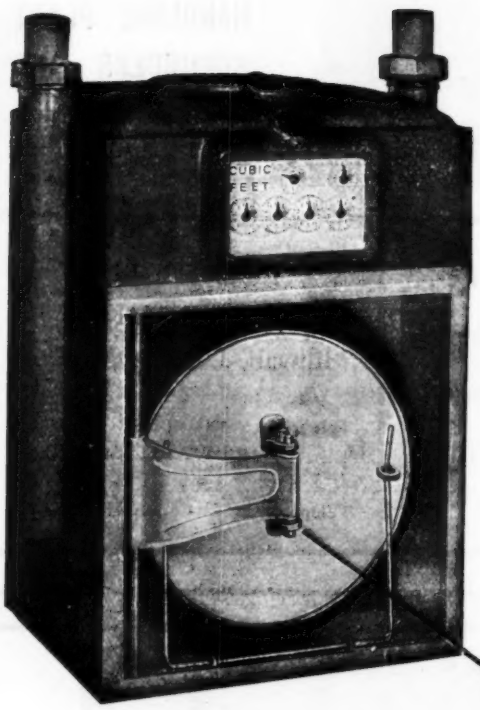

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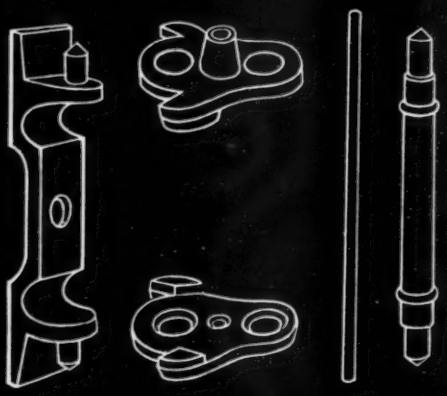

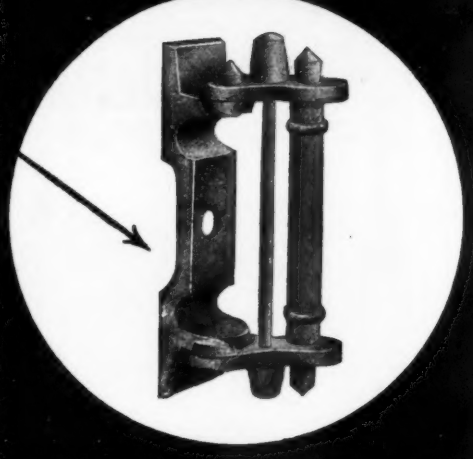

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mum cost is a very important factor in the economics of street lighting by gas, *vis-à-vis* its one and only competitor. And therefore the evaluation of the relative importance of the various factors contributing to depreciation has a considerable commercial value. The Gas Industry has always contended that the allowance for depreciation in the British Standards Institution Specification of as much as 50 per cent. is far more than is desirable—or necessary where the lighting is by gas. This latter statement is confirmed by the investigations described in the Report, which show that the light depreciation of gas lamps need not exceed 30 per cent. with reasonable maintenance.

When reading the Report in preparation for what I might say by way of introduction at this Meeting, I noticed what I thought to be an omission. No reference is made to the use of governors on the lamps that were tested, and it appears to be taken for granted that the gas pressure on an ordinary lighting installation is substantially constant. In many districts that is a perfectly safe assumption; and, where it is not, the practical result generally is that more light than is paid for is provided at times when it is not so much required. Nevertheless, I would urge the desirability, on commercial and other grounds, of maintaining the greatest practicable uniformity in all gas lighting installations, and would recommend the use of governors on the lamps in all cases where the pressure is not known to be practically invariable during the lighting hours.

The Departmental Committee.

Now I would like to make a few remarks, if I may, about other parts of the Joint Lighting Committee's work during the past year. Street lighting has been the main theme because the year has been an exceptionally eventful one in that respect. The principal event was the setting up by the Ministry of Transport of a Departmental Committee on Street Lighting, with whose terms of reference I expect you are all familiar—viz.:—

> "To examine and report what steps could be taken for securing more efficient and uniform street lighting, with particular reference to the convenience and safety of traffic and with due regard to the requirements of residential and shopping areas, and to make recommendations."

Incidentally, the Joint Lighting Committee felt highly honoured when it was learned that one of their members, Mr. C. A. Masterman, had been appointed by the Ministry a member of the Departmental Committee. In September last the Departmental Committee published an Interim Report after receiving memoranda, and in the majority of cases, taking oral evidence, from as many as 19 bodies, including the Joint Gas Lighting Committee acting on behalf of the National gas bodies. The summary of conclusions of the Departmental Committee has been added as an appendix to the Joint Lighting Committee's Report that I have presented this morning. It is obviously too much to expect that any one of the bodies who have given evidence will agree with the Report *in toto*, or indeed that the members of one body should agree among themselves—so complex are the considerations involved. And I suggest that it would be undesirable to embark upon any discussion of the conclusions and recommendations at this meeting. In any case, what we should be chiefly concerned with is that gas undertakings and manufacturers of gas lamps should realize that this Report will stimulate the demand by the public via the Lighting Authorities for improved street lighting, and that every possible effort should be made to ensure that gas lighting plays its full part in this development. That will be greatly to the benefit of the community as a whole, which is not, I think, properly grateful to the two great industries that vie with one another in giving better and better value for money—even to the point where there is no money in it.

It is noteworthy that the Departmental Committee is quite definite in its conclusions as to the mounting height, overhangs and spacing of the lighting units for traffic routes, and that the reference to a generously planned Class F installation of the British Standard Specification is an important point of reference to the working conditions we have become more or less accustomed to.

Another important event in the lighting world this year was the Congress in Berlin, last July, of the International Commission on Illumination. Unfortunately, I was unable to attend the meeting, and the Industry is very much indebted to Mr. Butterfield for acting as leader of the delegation of ten members, who, with Mr. F. C. Smith as Deputy-Leader and Secretary, played an active part in the very interesting discussions that took place.

Of the many other activities of the Committee during the last twelve months, I would like to make special mention of the efforts being made to obtain a British Standards Specification for gas mantles. A specification has been drafted, and the Committee is now looking forward to agreement with representatives of the mantle manufacturers in order that the agreed draft may be forwarded to the British Standards Institution with every prospect of the final specification being published at an early date. This should be of great value in defining the performance to be anticipated from mantles of standard dimensions and quality. A closely related question under consideration by the Committee is the design of gas lighting burners in relation to efficiency and appearance. The fact that we have representatives of the Society of British Gas Industries as members of the Committee has enabled us to enlist the help of the manufacturers in regard to this problem, and others. We are hopeful that by the co-operation of all concerned improvements may be effected and the lines of further progress established.

Mr. C. A. MASTERMAN (Gas Light and Coke Company): Among the events of the year in the world of lighting of interest to The Institution of Gas Engineers, the Interim Report of the Departmental Committee on Street Lighting, just published, must rank as one. As I am a member of the Committee my comments on the Report must be discreet rather than critical. Among those giving evidence before the Committee you will remember the Joint Lighting Committee was one of the first.

Any report of this kind must necessarily represent the greatest common factor of agreement among a number of people not necessarily holding similar views, but if the Report appears to have little that is new to those familiar with street lighting there is little doubt that it will carry considerable weight and effect a number of changes in quarters where hitherto street lighting has not been sufficiently carefully considered. The Report will already be familiar to many of you and you will have appreciated that it represents a compromise, especially on a number of factors where no general conclusion has been reached, and on other factors where there is general agreement but no quantitative method of giving expression to that agreement. There is no doubt, for instance, that glare is a deplorable factor in certain street lighting installations and may prejudice what might otherwise be an entirely satisfactory installation. From a scientific point of view, however, even a very complex definition of glare may be quite inadequate, and it has been possible in the Interim Report only to set out certain simple considerations in the hope of diminishing the most extreme forms of glare.

The relative importance of road surface brightness is another factor which has given rise during recent times to an immense amount of discussion, and as yet no one has been able to propose any quantitative definition of road surface brightness in relation to visibility which could be of value in any specification or installation requirement.

The Report of the Departmental Committee chiefly concerns itself with the lighting of traffic routes in connection with which the B.S. Specification has not been found wholly acceptable, although many of its provisions are referred to in the Departmental Committee Report. The recommendations have as their aim the ensuring of such lighting on traffic routes as to allow traffic to proceed safely at 30 miles per hour without headlights. Subject to certain other provisions, the Report suggests that such a standard of lighting can best be described as involving lighting units of at least the number and power of those required for Class F of the B.S. Specification. It is appreciated that this is a somewhat flexible definition and one required to be interpreted into being by a competent lighting engineer. It is also appreciated that not all of the lighting of traffic routes is subject to competent technical control. Certain administrative changes are recommended in the report to facilitate the exercising of such control and to ensure the financial ability of the authority to carry the burden of adequate lighting of the required standard. These changes, if and when they are carried into effect, will undoubtedly lead to increased demand for technical information from the parties submitting tenders, one of whom is likely to be the local gas undertaking.

It may be that some of the smaller undertakings will find their technical resources in connection with street lighting inadequate to deal with these more searching standards, and that they will to an increasing extent find it desirable to seek the assistance of the makers of gas lighting fittings who are always ready to help, and several of whom have latterly set up competently staffed laboratories to deal with such problems. They are no doubt at the present time engaged, as we are ourselves at Watson House, in planning out on paper lighting installations to fulfil the requirements of the Ministry Committee with the various street lighting fittings which are now available. No doubt the results of this work will become available in due time through the Joint Lighting Committee.

You will have seen references in the Departmental Committee Report to an experimental installation which has been set up and on which tests are in progress. Clearly any such single installation must be extremely limited in its scope and in the conclusions which can be drawn from

it. The experimental work of the Committee, however, is not confined to this single installation, but can be expanded and is being expanded to cover other conditions; indeed you will see in the Report itself acknowledgment of demonstrations staged by the South Metropolitan Gas Company for the benefit of the Departmental Committee. The further conclusions which are reached in due time as a result of this experimental work and other surveys will doubtless be embodied in some later report—which report I imagine will also deal with the lighting of side streets which in mileage represent, of course, many times that of traffic routes.

This is not the occasion for me to refer in any detail to the many technical points involved in street lighting which are just now the subject of so much controversy, more especially as these were very fully discussed at the recent discussions at the Conference of the Association of Public Lighting Engineers and were fully reported in the Technical Press. This present occasion, however, does appear to present an opportunity for especially drawing your attention to the Interim Report of the Departmental Committee on Street Lighting which inevitably must be of great importance to members of this Institution.

Quite clearly, you will not all agree with the Ministry Committee's findings, and there has been a good deal of discussion, even argument, inside the Ministry Committee itself. No one feels that the last word has been said. If you have alternative points of view to put forward and any suggestions to make, it seems to me that there is open to anybody a definite procedure whereby the views of the Ministry Committee can be influenced, and that is to raise the suggestions with the Joint Lighting Committee. If the Joint Lighting Committee feel that the suggestions are worth pursuing, it is up to them, I know, to approach the Ministry again for permission to submit further evidence and at any time to demonstrate new types of street. If you do feel that the report does not meet your own views, that is a way in which they can be brought to the notice of the Ministry Committee, and possibly some notice can be taken ultimately of your views in a later report. I mention that because it must not be supposed for a moment that the present report is final and that nothing can be done about it.

Impressions from the International Commission.

Mr. W. J. A. BUTTERFIELD (Gas Referee): It has been suggested that a brief reference to the impressions gained by the delegates appointed to represent the Gas Industry at the International Commission on Illumination held in Berlin, Karlsruhe, from July 1 to 10, 1935, may be of interest to the members of The Institution of Gas Engineers.

It will be recalled that the last International Commission on Illumination was held in Great Britain in 1931 and members will remember the immense public interest which was occasioned by the flood lighting displays arranged at the various places visited by the Commission. The more serious work of the Commission, however, is not so well known, and a few notes relative to this aspect may be helpful. Each participating country appoints a National Illumination Committee which is representative of all the lighting interests in the country. These National Committees act as the Secretariats and arrange for the collection of data or the intensive study of the particular problem or problems allocated by the Commission to the country concerned. Prior to the Conference the Secretariat reports are issued to the delegates, and these reports form the basis of the discussions at the various sessions. The Commission was welcomed on behalf of the German Government by Dr. Lippert. The technical sessions of the Commission were held this year in Berlin and Karlsruhe, and were attended by a delegation of 10 members accredited by the Gas Industry. The presence of our President, Col. W. Moncrieff Carr, was much appreciated. The delegation was led by Mr. W. J. A. Butterfield, and Mr. F. C. Smith acted as deputy Leader and Secretary.

At the Congress this year such fundamental subjects as Vocabulary, Definitions, Standards of Light, Precision Photometry, Physical Photometry, Glare, and Photometric Test Plates were considered. In addition the more practical aspects of lighting were discussed at meetings dealing with Public Lighting, Lighting of Factories and Schools, Architectural Lighting, Day and Artificial Lighting, and the Lighting of Mines. The international codes affecting the lighting of aerodromes were also dealt with. Other interesting subjects were Colorimetry, Light Diffusing Materials, and Lighting Education.

At the conclusion of the sessions the resolutions adopted in Committee are submitted to a Plenary Session, and if passed are forwarded in due course to the various National Secretariats. These resolutions are of importance since they very largely determine the nature of the technical work undertaken, and have direct repercussion upon lighting practice in the countries concerned. Hence it is apparent that these resolutions may be of commercial as well as technical significance. The resolutions adopted at the Congress will be published in due course by the Bureau, but the importance of some of these resolutions may be illustrated by reference to one or two which are of peculiar interest to the Gas Industry. For instance, the Committee adopted a scale of minimum values for illumination in schools, and recommended that the scale should be exceeded in the interest of human efficiency, comfort, and eyesight preservation. It is important that gas engineers should be familiar with these recommended values, as school authorities arranging for the lighting of schools and colleges will probably demand that at least these minimum values shall be provided in future.

In regard to street lighting, the National Committees were asked to study the importance of the brightness of the road surface, and its distribution, in revealing objects in the street, and the method by which this brightness can be produced and controlled. It was also recommended that a committee should be formed to study railway lighting. The British Gas Delegation was well represented at practically every meeting of the session and a report has been prepared and is available in the library of The Institution of Gas Engineers.

The session dealing with street lighting was of peculiar interest, and it was obvious that Continental countries were interested in road brightness and its effect upon visibility. In general it appeared that more work has been done in this direction in this country than on the Continent, although the reflection values for various road surfaces have been studied extensively by M. Cohu in France. Some British delegates suggested that high road brightness was best obtained by a high intensity beam near the horizontal, but this contention was not acceptable to many of the delegates without further confirmatory work. It was considered that both discomfort and disability glare were likely to be excessive under such conditions. Many delegates preferred a partial cut-off near the horizontal or the provision of a translucent screen in order to limit the intensity of the candle power at angles down to, say, 5° below the horizontal. Considerable work has been done in Germany making use of mirror glass reflectors providing a partial cut-off, and this practice was referred to during the discussion.

Other delegates emphasized the importance of backgrounds other than the road surface and stressed the point of view that the study of promotion of visibility in public thoroughfares should take into account the kinetic aspect of the street lighting problem. It was clear that many aspects of the street lighting problem require careful study before the matter is entirely understood, and it is of interest to note that Great Britain is now the Secretariat Country for this subject.

The meeting dealing with lighting education was also of interest. The subject matter dealt with at this meeting could be, broadly speaking, divided into two headings:

(*a*) Discussion of the technical facilities available for the training of lighting engineers, and

(*b*) Stimulating the general public's interest in good lighting.

Mr. Stickney, of the U.S.A., reported that a study lamp had been developed in America in order to make the public "light conscious." The speaker stated that they had anticipated a sale of 3,000 per annum of these units. The actual sales had been 600,000. It is of interest to note that the British Standards Institution are preparing a specification for a study lamp and the Gas Industry has been invited to co-operate on that Committee.

An inspection of many interesting street lighting installations was arranged. It should be noted that in Berlin approximately 80 per cent. of the street lighting is carried out by either high or low pressure gas. Interesting installations of mercury and sodium discharge tube lighting were visited, and in each case it was noteworthy that considerable thought had been put into the design of the fittings in order to avoid glare. In this respect Continental practice differs considerably from much accepted practice in this country.

The Delegation were also able to visit the works of Messrs. Zeiss Ikon, where Dr. Klein explained in detail the tests he had designed for testing street lighting installations. The works and laboratories of the Siemens Company were also visited. Interesting examples of floodlighting of parks and buildings were arranged for the benefit of the Commission in Berlin and Karlsruhe.

We were also able to visit the Technical College in Karlsruhe, and were shown the extensive equipment available for the training of lighting engineers. The Congress was preceded by meetings of the German Illuminating Engineering Society, to which foreign delegates were invited. At these meetings an interesting Paper was read by Herr Seeger, in which he computed that some 30 per cent. of the total electrical load in Great Britain was for light-

ing and that this 30 per cent. represented over 60 per cent. of the revenue received by Electrical Undertakings. A translation of this Paper is available.

Another interesting Paper was read by Ing. Muller, of Hamburg, who dealt with the "Status of Street Lighting by Gas and Its Influence upon the Economics of Gas-Works." This Paper was very informative and was well received. Herr Muller gave statistics relative to gas lighting in Germany. Slides were shown of examples of English gas lighting practice and included photographs of the old and new lighting in New Street, Birmingham, the floodlighting of Donaldson Hospital, Edinburgh, and St. Mary Abbotts Church, Kensington, during the Jubilee Celebrations. In addition, slides of English floodlighting units were projected.

One cannot conclude this brief reference to the International Commission on Illumination without referring to the extreme kindliness with which all the delegates were received by our German host. So far as the Gas Delegation was concerned our gas engineer colleagues in Germany did all in their power, often at considerable personal inconvenience, to make the visit informative and worth while.

On Behalf of the Lamp Manufacturers.

Mr. P. SUGG: I have not the honour of being a member of your Institution, and therefore I greatly appreciate the opportunity afforded me to say a few words on behalf of the lamp manufacturers. I do so in my capacity as Chairman of the Lighting Section of the Society of British Gas Industries, and I can assure you that the members of that Section do feel very obliged to all those gentlemen who, as members of this Committee, have drawn up this Report. When taken in conjunction with the British Standards Institution's Specification it does enable us to realize fully what we are supposed to provide and we hope that it will make for some degree of uniformity of practice. At present it is very difficult for the manufacturer to know exactly what type of lighting he is asked to supply, and in a very large number of cases we find that that which suits one undertaking is not acceptable to another.

I have examined the Report carefully and I have discussed it with one or two of our members who are interested in the manufacture of public lamps, and we are absolutely in agreement with the statements made therein. I was very pleased that Mr. Lacey mentioned the question of governors. I had anticipated that they would have been strongly recommended as being standard on all lamps. They are a very vital part of the lamps themselves, and half the troubles which we find and have to correct are due to alterations in pressure. I think that a governor should be as standard on the lamp as is a speedometer on a motor car, and I hope the day is rapidly approaching when it will be accepted as such.

I was very interested in the reference made to the depreciation factor. Some time ago it was argued strongly that we must have a 50 per cent. allowance. I see that the Committee has decided that 30 per cent. is sufficient, and the figures which are given in the Report were very well confirmed by a case which we examined only about three weeks ago. We were asked to make some tests for a local council, whose lamps had been in use for three years. They had been cleaned a week before our tests, and the depreciation factor was only 23 per cent.—*i.e.*, the efficiency value was only 23 per cent. below the rated value. That seems to confirm very well the figures given in the Report when we consider there is always a tendency for reflectors to become slightly brown after three years' service.

With regard to the mounting height, I think the conclusion stated in the Ministry of Transport Committee's Interim Report is a little too strong, and I hope that our own Committee will manage to persuade the Ministry not to state that "In general, a mounting height of 25 ft. with 6 ft. overhang, is desirable." That implies the employment of a very large or a fairly large unit, whereas the majority of streets would not admit of such a mounting height. Undoubtedly, the higher the units, the better, but I do not think that the terms used in that conclusion of the Ministry's Committee should be used.

We as manufacturers heartily welcome the suggestion that a plug injector should be easily removed. That is certainly a very good point, because, as stated, more trouble arises through a dirty injector than through any other cause. I should also like to assure members of this Institution that the manufacturers are in a position now to give you every possible assistance in your lighting problems. My Company has an excellent laboratory and many others have equal facilities both for making laboratory tests and for following up those tests with a service which is always at your disposal.

The Ministry of Transport Report.

Mr. A. L. JENNINGS (Spenborough): I wish to speak with particular reference to the Interim Report of the Ministry of Transport Committee on Street Lighting. One of the points which I wish to raise has already been mentioned by Mr. Sugg, but I think it is so important as to justify reiteration. I believe there is a particular reference to high-power sources of lighting, and further on it is recommended that such lamps should be spaced 50 yards apart at a mounting height of 25 ft., with 6 ft. overhang. Also I believe that in the general conclusions it is recommended that generally speaking the spacing of lamps should be 50 yards and the mounting height 25 ft. In other words, it seems to me that they are recommending generally a spacing for lamps which is only suitable for high-power lamps, and I think that if that clause is included in the general conclusions it should be made perfectly clear that it refers to high power lamps and not to lamps of lower candle power.

It is also stated that it is advisable for adjacent undertakings to collaborate with reference to street lighting where there is overlapping or that many authorities could join together in dealing with roads which are close to each other. That is all to the good, very probably. It is also stated that it might be well to place the responsibility for the lighting of main roads in the hands of central authorities such as county boroughs and county councils. I hope that before The Institution of Gas Engineers thoroughly agrees with that view it will satisfy itself that the Gas Industry will have a fair crack of the whip in the event of that procedure being adopted. I am sorry to say that in my humble opinion legislation which has emanated from Government Departments in the past has not always given to the Gas Industry the consideration which it has given to our friends in the electrical industry.

Mr. C. A. MASTERMAN, in reply to Mr. Jennings, said: I am a little confused by Mr. Jennings' remarks and have not understood him aright. He was suggesting, I think, that a recommendation in the Interim Report of the Ministry of Transport Committee was intended to be regarded for some reason or other as being confined to high-pressure light sources. That is in no sense correct. It is quite a general recommendation that the spacing should not exceed 150 ft., and a general recommendation that the height should be not less than about 25 ft. and that the number and power of lamps should be of the order of Class F. I do not know how the misunderstanding can have arisen. There is room for difference of opinion as to whether the recommendations are right or wrong. The recommendations regarding mounting height, which may strike you as being rather extravagant, arose because if you take a cost analysis of maintenance and erection you will find that generally speaking it does not make a great deal of difference whether your mounting height is 22, 23, 24, or 25 ft. It is generally accepted among engineers that the higher the mounting height the better, and the Committee made the general recommendation that we should go as high as possible, which appeared to be about 25 ft.

As a Member of the Ministry Committee, I might say that we should all resent very much indeed any suggestion of lack of complete impartiality on behalf of the Ministry in the conduct of that Committee's work. We have met with an extremely fair reception; I think the electrical people and ourselves would be bound to say that. I think we ought to resent very keenly any suggestion that any other circumstances had cropped up.

Appreciation of the Work of the Delegation.

The PRESIDENT: I should like to take the opportunity to express to this meeting on behalf of the Council our great appreciation of the work done by Mr. Butterfield, Mr. F. C. Smith, and all the other members of the delegation to the International Illumination Congress in Berlin. I was able to go there only for one day, but I do appreciate the manner in which gas lighting was upheld by the British delegation, and particularly I appreciate the work of the younger members of the delegation, who actively and bravely took part in the discussion in the various sessions. Gas was maintained in the forefront at that conference, and that fact was due in no small measure to the work of the delegation organized by this Institution and so ably led by Mr. Butterfield.

With regard to the greater use of a standard specification, we are still face to face with the difficulty indicated by Mr. Lacey and one other speaker, that there are many lighting superintendents who have other duties—who are surveyors, perhaps, to small local or rural authorities—and who, although they are able men in their way, have had neither the facility nor the opportunity to acquire the technical knowledge which is so essential to the provision of efficient lighting. I do hope the Interim Report of the Departmental Committee will lead, as is already indicated, to a better control. I do not share the view of Mr. Jennings, that that better control will be detrimental to gas, if that control is to be centralized under those who have the technical knowledge and ability to appreciate

what is required by the specifications that have been laid down.

The work which has been done by the Joint Lighting Committee during the last twelve months is invaluable, and not the least important part of it is that work which has been done abroad.

Mr. LACEY: I will try to add to the explanation Mr. Masterman has given with regard to the comments of Mr. Jennings concerning the mounting height of 25 ft. recommended in certain circumstances—and those circumstances are important. The recommendation applies to the lighting of traffic routes. One of the recommendations of the Departmental Committee is that traffic routes should be so lighted that traffic may proceed safely at 30 miles per hour without headlights, and the amount of light required is represented by a generously designed Class F installation of the British Standard Specification. What it really comes to is that, in order to light the traffic routes to that degree, it is necessary to have, not high-pressure lamps, but relatively high-power lamps at the mountings and spacings recommended. I rather think Mr. Jennings had in mind that the mounting height mentioned referred to all streets and not merely to traffic routes, which latter have to be generously illuminated.

1st and 2nd Reports of the Meters Committee

The Institution of Gas Engineers' Specification for Gas Meters for Domestic Consumers

(1) GENERAL.

The Meters Committee of The Institution of Gas Engineers has given considerable attention to the rating of Meters and matters arising therefrom. On several occasions representatives of the Meter Makers joined in these deliberations at the request of the Committee.

The Committee early became impressed with the need for a reduction in the number of classes and sizes of Meters. The change from describing a Meter by the "Number of Lights" it was intended to serve was made in June, 1922, when a Joint Committee of The Institution of Gas Engineers and The Society of British Gas Industries inaugurated "Standard Meters" to be known by numbers. This was followed later by the introduction of "High Capacity Meters" rated at cubic feet per hour. All three designations are still in use. Recently another series of Meters has been introduced, an important feature of which was a reduction in outside dimensions in relation to Meter capacity. It was reported to the Meters Committee that the Gas Light and Coke Company were buying this type of Meter and had drafted a complete Specification in which size of case, centres of pipes, types of valves and indexes and other features to suit their requirements were stated. This Specification was carefully considered by the Committee, but it was felt that any attempt by the Committee to standardize this or any other special type of Meter was at this stage premature. The alternative of issuing a Specification drafted so widely as to embrace several classes of Meter would not, the Committee considered, be sufficient to attain the object they had in view—namely, to standardize Meter capacities and to decide the lines on which future developments would be dealt with in a Specification for Gas Meters.

The present Report is, therefore, drafted in general form, referring to the matters which have come under review in the hope that further information—especially of a statistical kind—may be submitted by various Gas Undertakings in the country for consideration.

(2) CAPACITIES.

Although it is too early to standardize Meters on any rigid basis, the Committee have considered a number of points having reference to the desirability of limiting the classes and modifications which are available. A number of tests have been carried out, the object of which was to determine if the average maximum gas rate experienced in Domestic houses could be classified in such a way as to indicate the most desirable capacities for Domestic use. The results of such tests were unfortunately inconclusive, but they showed that the average maximum gas rate was very much less than might be anticipated from the aggregated consumption of the Gas Appliances in the house. Although, from figures obtained, the opinion was formed that Meters of 100, 200 and 400 cu.ft. per hour maximum capacity would be respectively suitable for most "Prepayment," "Ordinary" and larger "Ordinary" consumers, the Committee would welcome further statistical information on this point and as to the appropriate capacities for Industrial Meters.

(3) BADGING.

It is agreed that Meters should be badged at their true maximum capacity and it is of some concern to the Meter Makers that this maximum figure should not normally be exceeded, as they accept certain responsibilities under their Guarantee.

(4) DIMENSIONS.

The dimensions of the Meter case of the recognized classes of Meter show considerable variation as between various Makers. This may often be a matter of small importance, but a standardization of the centre to centre dimension of the connections would seem desirable, since this dimension may affect the facilities for exchanging Meters. This would apply more especially to those Undertakings using a Meter bar instead of lead connections. Attention is being given to the standardization of Meter Unions, the Standards set up by the Standards Office of the Board of Trade in 1902 having proved inadequate to guarantee interchangeability.

(5) TYPES, MECHANISM AND CONSTRUCTION.

Dimensions of Meters are further affected by the construction in that they may be of the closed or open top type. There is a definite difference of opinion between Gas Undertakings as to the merits of each type and statistical evidence and practical experience on the subject would be of assistance to the Committee.

There is a variation between Gas Undertakings in regard to the index, some preferring the direct reading index and some the dial type. The Committee would welcome the experience of those using the former index. Further points affecting Undertakings on which information is sought, relate to facilities for greasing the stuffing boxes and oiling the valve faces, &c., *in situ*.

The construction of the Meter may be said to be primarily the responsibility of the Makers, in that its correct performance over a period of years is guaranteed. It is felt, however, that the Makers would welcome assistance from Undertakings whose direct experience with the Meters should yield valuable results. The factors in construction and design from this point of view are many, among which may be mentioned the quality of the tinplate; the metal and type of valve gratings and covers; the leather, its dressing and attachment; design of stuffing boxes, &c. Any useful statistics bearing on these points could conveniently be classified by the Committee and discussed with the Meter Makers.

(6) SPEED.

The progress of Meter design over a period of years may be fairly summarized as one in which the size of case has diminished relative to the Meter capacity. No doubt, in the initial stages of Meter development, the controlling factor which determined the capacity of the Meter was the range over which correct registration could be obtained. This range increased with improvements in design, but the pressure drop through the Meter became in some cases excessive.

"High Capacity Meters" may be obtained to-day in which both registration and pressure drop are found to be satisfactory, over a range so wide that excessive pressure drop is only reached when the speed of Meter operation is very much more than that to which the Gas Industry has become accustomed. The Committee considered certain figures regarding the behaviour of Meters at exceptionally high speed, and records were obtained of Meters working satisfactorily over a period of months on Gas Engines up to a speed of over 6,000 revolutions per hour. This is more than twelve times the maximum rate for the "High Capacity Meter." Although this speed may appear somewhat exceptional, it must be emphasized that in the terms of normal mechanical statement, this maximum is only 100 revolutions per minute. Until more experience is gained, however, with these higher speeds, it is felt desirable to consider 1,000 revolutions per hour as a maximum.

By acceptance of this speed of 1,000 revolutions per hour a considerable reduction in size of case is made possible. Apart from the practical convenience of a smaller size case, together with a reduction in cost for equal capacity, improvement in design and manufacture will tend to result in a smaller figure for the passing of unregistered Gas. This is of particular importance, in view of the increasing number of Gas Appliances now in use, which depend for

utility upon remaining alight for prolonged periods at low Gas rates. The Committee consider that for the three sizes of Meter abovementioned—100, 200 and 400 cu.ft. capacity—the allowable pressure drop between the inlet and outlet unions (*i.e.*, the average figure over one complete revolution of the rated capacity) should be, tested with air, 3/10 in. for "Ordinary" Meters and 4/10 in. for "Prepayment" Meters.

(7) Questionnaire.

Appended is a "Questionnaire on the Proposed Standardization of Gas Meters" which has been sent, with a copy of this Report, to all Gas Undertakings making and/or repairing Meters. Other Undertakings interested are invited to reply to the Questionnaire.

(1) The Meters Committee has obtained information regarding Domestic consumptions, which suggests that Meters of:—
  (*a*) 100 cu.ft. per hour capacity would cover the requirements of most Pre-payment Consumers.
  (*b*) 200 cu.ft. per hour capacity would cover the requirements of most Ordinary Consumers.
  (*c*) 400 cu.ft. per hour capacity would cover the requirements of larger Ordinary Consumers.
  Do your statistics confirm this view?

(2) Do you prefer, and for what reasons, the closed or open-top type of meter?

(3) What is your experience with the direct-reading index and do you prefer it to the dial type?

(4) What experience have you of devices providing facilities for:—
  (*a*) Greasing the stuffing boxes *in situ*?
  (*b*) Oiling the valve faces *in situ*?

(5) Give your views on:—
  (*a*) Quality of tinplate.
  (*b*) Metal and type of valve gratings and covers.
  (*c*) The leather, its dressing and attachment.
  (*d*) Design of stuffing boxes.
  (*e*) Any other features of construction and design in which you are specially interested.

(6) What percentage of "Lights," "Standard" and "High Capacity" Meters do you now purchase?

(7) Do you make and/or repair Meters?

29th November, 1933.

2nd REPORT OF THE METERS COMMITTEE; THE INSTITUTION OF GAS ENGINEERS' SPECIFICATION FOR GAS METERS FOR DOMESTIC CONSUMERS.

(1) Explanatory.

The Meters Committee of The Institution of Gas Engineers has prepared, after consultation with the Meter Makers, "The Institution of Gas Engineers' Specification for Gas Meters for Domestic Consumers" hereunder.

The Replies to the Questionnaire referred to in the 1st Report of the Meters Committee confirmed the views expressed in that Report as to suitable Gas Meter sizes for different classes of Domestic Consumers and the three sizes specified hereunder are respectively regarded as being suitable for "Prepayment," "Ordinary" and larger "Ordinary" Domestic Consumers.

These three sizes of "I.G.E. Gas Meter" are named "D 1," "D 2," and "D 4," the case dimensions corresponding approximately with the case dimensions of "Standard Meters" Nos. 1, 2 and 4.

The rated capacities specified are 100, 200 and 400 cu.ft. per hour. Should technical development result in increased capacities, the case dimensions of "I.G.E. Gas Meters" would remain unaltered.

The maximum speed specified represents what is generally accepted for Meters of the sizes specified. The sizes of connections are prescribed.

Careful consideration has been given to the standardization of Meter Unions for "I.G.E. Gas Meters" and a British Standard Specification is being prepared to embody the recommendations of the Meters Committee and, when issued, will form part of the Specification for Gas Meters.

It is found that with "I.G.E. Gas Meters" for "Ordinary" Consumers, the pressure drop, when tested on Gas, rarely exceeds 2/10 in. water gauge.

Unless the Specification hereunder is generally adopted by the Gas Industry, the desired reduction in the number of classes and sizes of Meters will not be effected and the position, instead of being improved, will be further complicated. It is recommended, therefore, that Gas Undertakings should in future order Gas Meters to comply with "The Institution of Gas Engineers' Specification for Gas Meters for Domestic Consumers."

Meter Design and Construction and the Quality of Materials have purposely been omitted from the Specification.

(2) Specification.

1. "I.G.E. Gas Meters" for Domestic Consumers shall comply with the requirements of Table A and Figure 1.

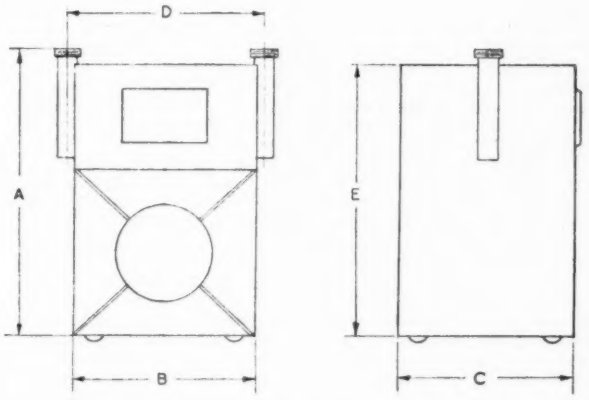

Figure 1.

Table A.

Name of Meter.	Capacity per Hour; Cu.Ft.	Size of Inlet and Outlet; Inches.	Maximum Speed; Revs. per Hour.	Maximum Pressure Drop, Inlet to Outlet; Inches.		Case Dimensions; (see Figure 1) Inches.				
						A	B	C	D	E
1	2	3	4	5	6	7	8	9	10	11
				Ordinary.	Prepayment.					
D 1	100	$\frac{3}{4}$	1,000	$\frac{3}{10}$	$\frac{4}{10}$	$11\frac{3}{8}$	$7\frac{1}{2}$	$7\frac{1}{2}$	$8\frac{1}{2}$	$11\frac{1}{2}$
D 2	200	1	1,000	$\frac{3}{10}$	$\frac{4}{10}$	$14\frac{3}{8}$	10	9	$10\frac{3}{8}$	$14\frac{1}{2}$
D 4	400	$1\frac{1}{4}$	1,000	$\frac{3}{10}$	$\frac{4}{10}$	$18\frac{1}{2}$	13	$10\frac{3}{4}$	14	$17\frac{3}{4}$
				Tested on Air		Excluding any prepayment attachment. Not to vary more than $\frac{1}{4}$ in.				

Table B.

Name of Meter.	Tolerances during 1936 to 1940 on Case Dimensions in Table A: Inches.									
	A		B		C		D		E	
	+	−	+	−	+	−	+	−	+	−
1	2	3	4	5	6	7	8	9	10	11
D 1	2	0	$\frac{5}{16}$	0	$\frac{1}{8}$	$\frac{1}{16}$	$1\frac{1}{8}$	0	$2\frac{1}{2}$	0
D 2	0	$\frac{3}{8}$	0	$\frac{7}{16}$	0	$1\frac{1}{2}$	0	$\frac{7}{8}$	$\frac{5}{8}$	$\frac{1}{2}$
D 4	$\frac{5}{8}$	$\frac{3}{8}$	0	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$	0	$1\frac{1}{2}$	$1\frac{1}{2}$	$\frac{3}{4}$

2. A change-over period of five years from 1st January, 1936, is allowed, during which period the tolerances shown in Table B will be permitted, thus enabling "Standard Meter" cases Nos. 1, 2 and 4 of different Makers to be used.
3. Each Meter case shall have the specified sized connections. The dimensions of centres of "inlet to outlet" shall be measured on a line parallel to the centre line of the Meter.
4. Meter Unions shall accord with the British Standard Specification now being prepared.
5. A Meter supplied as complying with this Specification shall be described as conforming with "The Institution of Gas Engineers' Specification for Gas Meters for Domestic Consumers" and designated an "I.G.E. Gas Meter." If so supplied the Meter shall be legibly stamped "I.G.E."

29th November, 1934.

Introduction.

Mr. JOHN TERRACE (Chairman of the Meters Committee): On behalf of the Meters Committee I now present to you the proposed Institution of Gas Engineers' meters specification. The Report before you is divided into two parts. The first Report gives the history in connection with the work of the Committee. It is some considerable time ago since we started, when we reviewed very carefully the position at that time; to some extent the position is the same to-day. But you will notice that particulars are given of the three different specifications of standards of meter that were in existence when we started; these still obtain to-day, although perhaps not to the same extent.

As the result of the 1st Report, a questionnaire was sent out, and with the further knowledge gained from the replies the Committee commenced to make a definite specification, which is given in the 2nd Report. It is very short. We have tried to ensure the support of the whole Industry, because, unless we do, the position, if this specification is accepted, will be worse than it was before. The three sizes mentioned refer to domestic meters. The problem of larger size meters was found to be very difficult and was left over for the present. What we tried to do was to take into account all the experience and information available and arrange a specification which would have a reasonable chance of acceptance by everybody. We make a very strong appeal to the Industry to take advantage of this, because eventually it will lead not only to greater satisfaction, but, we hope, to reduced costs.

The three sizes mentioned are those which we feel fairly sure, from the enquiries we have made, are suitable for what we call prepayment, ordinary domestic, and larger ordinary domestic supplies; and you will notice that the maximum speed at which these meters are to work is to be 1,000 revolutions per hour. The specification is arranged in such a way that if anyone should consider 1,000 revolutions per hour to be too fast it is quite easy for them to use the next larger size—the capacities are 100, 200, and 400 cu.ft. per hour—and reduce the speed to 500 revolutions per hour. It would appear from the wording of the specification that it might delay fitting meters with proper unions. The position with regard to unions is no different now from what it was, because they always have been more or less standard; indeed, I do not think there is the same difficulty with meter unions to-day as there was some time ago. But we have arranged with the British Standards Institution to make the specification for meter unions standard throughout the country, with the proper tolerances as arranged by the manufacturers.

We have purposely omitted matters which some people think ought to be put into a meter specification. For instance, we have not stated anything about the type of construction (whether it is to be of open or closed top), the type of index to be used, the quality of the tin plates or a specification for the leathers or any other part of the material, because we felt it would be unwise to do so. As I have said, we have tried to ensure the support of the whole Industry, and we felt that if we put in details of that kind we should not be expressing the general opinion about them, and we should create difficulties. The Gas Industry is very well served by the meter makers. For many years most of them, at any rate, have used the very best possible materials, in their own view, that they were able to obtain, and the Committee have left that part of the matter as open as possible. Also, we did not include any larger sizes because we could not secure any unanimous opinion on these points from the makers, and we considered also that it would be much better to feel our way by recommending, in the first instance, three sizes only and leaving it to time to show how they would be accepted.

In preparation for to-day's meeting I wrote to a few friends to ask if they would be present to give their views. Some of them are here, but some are not able to be present. Mr. James Jamieson, of Edinburgh, cannot be here, but he has taken the trouble to write quite a long letter in which he gives his views on several points. I will ask your permission to allow it to be included in the discussion; he did not say it was to be used for that purpose, but I think it would be quite useful. Generally, he agrees with the specification, and I do hope that several people who have come here this morning will let us know what they really think about it. Everyone agrees generally that it will be quite a good thing; but the main question is, what are you going to do to make it effective?

The PRESIDENT: Would you be good enough to read Mr. Jamieson's communication? I am sure the meeting would appreciate it.

Mr. TERRACE: After expressing his regret that he cannot be in London, Mr. J. Jamieson writes:

"I have read through the Report, and am in entire sympathy with the proposals; indeed, my fear all along in adopting high-capacity meters has been the high speed at which some of the meters submitted to us have operated, and, limiting the revolutions to 1,000 per hour gives us a sufficient reduction in case size to be helpful in every way. It has been our practice until now to adhere rigidly to the standard sizes of meters as laid down in the original report, and we have not gone far with the high-capacity meter, although we have a number on the district so that these might be tried out.

"I am very much in sympathy with your proposal, however, to adopt sizes 100, 200 and 400 cu.ft. capacities, as I feel that this range will give us a fairly reasonable margin for different types of domestic consumers, and the fact that the 100 cu.ft. meter case will be practically identical with the standard No. 1, and the output of the meter will be trebled.

"I am glad that you propose when presenting the Report to make a strong point that unless the proposals are universally adopted the position with regard to standardization of meters will be worse than it is now, and you can rest assured that we will be only too pleased in Edinburgh to adopt the proposals submitted by you in their entirety."

At the end of the letter there are some congratulatory remarks.

Discussion.

Mr. H. D. MADDEN (Cardiff): I very much appreciate the fact that my old friend, Mr. Terrace, the Chairman of the Meters Committee, has asked me to speak on this subject. In the first place, I think the President and he will agree with me that we are very much indebted to our assistants, who did a lot of the detail and spade work; I know they have worked very hard and long, because I have been in very close touch with the proceedings from the earliest stages.

The Report of the Meters Committee represents a definite advance of standardization, at the same time leaving scope for improvements which may be invented. The first important factor is that the specification provides for the new situation in the Gas Industry, in that domestic appliances can be used without overloading the meter, as the capacity is such that it will meet all requirements within its range. I would like particularly to point to the altering conditions. On Monday we have the washing load, which is becoming very heavy, and it merges with the cooking load at about mid-day. The ordinary meters would be over-taxed in meeting that demand. Another factor is that before this specification was produced, the large number of different sized meters required materially increased manufacturers' stocks, and, also, a variety of gas authorities' rentals was necessitated. It has also met the demand for a smaller meter case, as it is obvious that in these days there is no room for cumbersome measuring instruments. Especially is this so in the new housing schemes. In Cardiff we have quite a number of these high-capacity meters, and we have had them in use for some time, trying them out. It is too early yet to be able to say what are the results, but so far they appear to be very satisfactory.

Although the Gas Light and Coke Company issued their specification shortly after the inception of the Committee, it must be admitted that the members were working independently and yet arrived at similar conclusions. In this connection I think we owe another debt of gratitude to Mr. Lacey and the Gas Light and Coke Company for the spade work they have put in with regard to the specification of meters.

The suggestion made regarding speed was at first looked upon with some degree of fear, but it is quite evident that 1,000 revolutions per hour is mechanically slow, and no harmful results are likely to be experienced. The increase in the size of valves and gas ways is also of great advantage, and the pressure loss experienced is less than with many of the older types of meters. There is no attempt to create conditions which cannot be met by the manufacturers, and no hardship is imposed on them by the specification. In fact, the tolerances mentioned will be generally accepted as fair.

There remain to be settled one or two outstanding matters, such as the type of the indices used and the size

of the connections, but otherwise there is little left in abeyance. It is hoped that the Main Committee will permit the Meters Committee to continue their work and to standardize the large meters, so that the total number of meters to be made and stocked shall be few, but adequate for the whole range of the business of the Gas Industry. I think that, with the rapid growth of large consumptions in industry, the question of the large meter must be tackled; what Mr. Terrace has said emphasizes the necessity for this Committee to continue the work.

Widely Differing Opinions.

Mr. H. E. BENNET, M.C.: It occurs to me that one might amplify one or two matters, with the approval of Mr. Terrace, the Chairman of the Meters Committee. Opinions have varied very greatly in this country as to the types of meter that are to be used by gas undertakings. At a very early stage of the work of the Meters Committee the question arose as to what was the opinion of the meter makers on a certain matter, and a member of the Committee replied that he knew of few bodies of contractors who were more disunited or of more widely differing opinions on all matters than were the meter makers; in fact, that it was impossible to secure united views from the makers on certain points. That is probably the case. It is probable that the old tag used at school—*tot homines quot sententiae*—still applies to the meter trade and many others. However, the cure that was decided on was to send out a questionnaire and obtain an authoritative opinion from the gas undertakings. It was sent out, and it was rather interesting to find that the difficulty of widely differing opinion applied to more bodies of people than the meter trade alone. One of the questions asked was, " Do you favour closed or open top meters? If you do favour either, give your reasons." About 21 replies were received; 7 of those who replied had no strong views either way, 7 were very firmly in favour of the closed top, and 7 were very firmly in favour of the open top. So that that did not get us very much further. Similarly, a question was asked as to their views on direct-reading indices as against the ordinary dial type. Again, there were 7 all square, 6 down on bogey, and 6 up on bogey. You will appreciate that the Meters Committee, as the result of that questionnaire, did not receive quite that cogent assistance they had expected from the Industry, and there is no doubt that some people's views will be very contrary to parts of the Report. It is quite obvious that there is not unanimity on the matter, but the Committee hope that the country will give it a break in order to see whether it works out all right in the next few years.

The position from the meter makers' standpoint is exceedingly difficult. We have quite a large body of people who insist on having nothing but standard meters, an even larger body who insist on the large-case high-capacity meter, and others insist on the small-case high-capacity meter. That alone means carrying three stocks, and it is necessary for most of the meter makers to carry the three stocks. An even greater difficulty is presented by the number of gas undertakings which have individual specifications—not necessarily entire specifications, but specifications dealing with some special features to be incorporated in the meters they buy. In many cases the special feature has to be incorporated in the meter at a very early stage of manufacture; it is not something which can simply be tacked on to a meter from stock, but must be built in from the beginning, in many cases. So that the meter makers have to carry far more than three stocks; according to one maker, he has actually to carry twenty-one stocks. Necessarily, that has a bearing on costs. Mr. Terrace has expressed the view that the adoption of the specification will result in reducing costs; I think that will certainly be the case, but it is difficult to see how costs can move downwards substantially while there are, say, twenty-one specifications existing; many of them deal with very trivial matters, but those differences mean a considerable addition to the expense of manufacture.

Suggestion for an Inferential Meter.

Mr. JACQUES ABADY, K.C.: The Reports before the meeting appear to relate to the specification of standard forms of dry meter. It appears that, no doubt with the provisions of the Sales of Gas Act before them, the Committee have confined their attention to trying to introduce some standardization and consequential cheapening of the production of a positively measuring instrument, it being the premise that a positively measuring instrument is necessary to comply with the provisions of the Sales of Gas Act. As you know, I have nothing to do with the manufacture of meters and very little to do with the manufacture or distribution of the kind of gas in which the members of the Institution are interested; but it has long been a dream of mine that a radical alteration should be made in the method of measuring gas, with the idea of cheapening the installation in a flat, and particularly a worker's flat. I think it is correct to say that the provision of a meter represents quite a material part of the cost of that installation. I am wondering—and I throw out the suggestion with diffidence, it may have been made before—whether the Institution, which seems to have developed a most admirable and far-reaching research organization, has considered trying to devise a measuring instrument which, instead of being positive, should be inferential, either of the anemometer type or some other similar device. I believe the factors which would stand in the way of such a type of instrument measuring accurately would be changes in the specific gravity of the gas and changes in the temperature. I think that with the more strict test regimen and the development in the scientific aspect of the manufacture of gas, there is very little variation day by day in the specific gravity of the gas made in a particular area of distribution; if that is so, it seems to me to be possible to eliminate for all practical purposes the consideration of variations of specific gravity. It would be possible, of course, to make meters primarily designed to deal with gas of a gravity between certain limits, and there might have to be different grades if the gravity varies as between one part of the country and another. The second variant, that of temperature, seems to be one which should be taken care of in the design of the instrument.

I think it ought to be possible, if you could secure the accuracy, to produce a small measuring instrument which would be very cheap, which would measure, on the lines I am suggesting, the flow of gas; if that is so, I am wondering whether the Institution has ever thought of such a radical alteration in point of view, which would entail or might entail, an alteration in the provisions of the Sales of Gas Act. I believe that if, as the result of research—and it might be a long process—anybody could produce such an instrument at a very low price, small in bulk, and answering within reasonable limitations of divergence from absolute accuracy the needs of the Industry, the Board of Trade would be the last Department in the world to stand in the way of any reform of the law to enable such an instrument to be used.

Mr. STEPHEN LACEY (Vice-President): I am inclined to be on my guard against excessive or premature standardization, especially on a national scale, and, therefore, I claim it as a positive virtue that in the present circumstances the Meters Committee have attempted no more than a specification covering a small number of points. What they have attempted to do is to ensure that tried and proven meter improvements in respect of capacity in relation to size of case will be accepted both by the manufacturers and buyers of meters. Mr. Bennet has said that people are still buying lights meters. I think that is a horrifying thought; when we compare a lights meter with the other meters available to-day I cannot conceive how anybody can continue to buy the former; it is not worth the money, apart from any other consideration.

Towards Ease of Interchange.

The next thing the Committee have attempted is to limit the number of meter cases of different sizes in domestic use. Surely that is very desirable. Thirdly, they have attempted to ensure that the dimensions of meter cases of the same nominal size should be standardized so far as that is necessary to give ease of interchange on consumers' premises. I do not see how any one can seriously contend that this degree of standardization will hinder further development, unless one visualizes, as does Mr. Abady, some radical alteration in the meter mechanism that would involve a meter case of quite different proportions. If such a development on an entirely new line were to take place, and if the definite superiority of such a design over conventional types were established, no specification could prevent its adoption in the long run.

I can foresee very great difficulty in designing an inferential meter, for the one reason at least that it is essential in these days to measure very small quantities of gas and to measure over a very large range. An ordinary domestic meter has to measure quantities ranging from about half a cu.ft. per hour or less to 150 cu.ft. per hour, and I am inclined to think that it would be very difficult to design an inferential meter registering accurately over such a large range.

Leaving out of account such a possibility, the Meters Committee have allowed scope for and look forward to further increase of capacity in relation to size of case for a defined pressure loss, and further improvements in design and materials of construction in relation to the accuracy of registration and life of the meter.

We have been told by the Chairman of the Meters Committee that all this work may in the long run do more harm than good unless the specification is adopted universally. I am inclined to think that in actual practice the answer to the question as to whether or not the specification becomes effective will depend on whether it is adopted by the majority of the larger undertakings, because in these days the domestic gas meter is a mass-pro-

duction article, as Mr. Bennet has pointed out, and if a buyer asks for some departure from standard practice in a particular factory he must expect, on the cost of production basis, to pay more—indeed, he ought to pay more for it, unless he buys on a scale sufficiently large to enable him to impose his own standards. In my opinion, therefore, much depends on the larger gas undertakings. If a sufficient number of them adopt the specification, I feel, the smaller undertakings will follow.

It might be questioned whether one can properly buy meters to such a specification as this, which refers only to capacity and dimensions, even when the customary guarantee of the makers is taken into account. I think the answer is that the larger undertakings can look after themselves by having, as many of them have, a fuller specification of their own, and by requiring the manufacturers to submit a satisfactory production specification. I think that in practice the smaller gas undertakings might with advantage buy to the specification of a big buyer whose technical competence and judgment can be relied upon.

Mr. B. THORP: I could have said something in connection with the inferential meter, but I think Mr. Lacey has given the answer to the problem. Many years ago we made quite a good inferential meter, about the size of a tea-cup, and it was very accurate over a large proportion of its measuring scale, but the difficulty was with the lower quantities, and the Board of Trade were not really amenable to any argument in that connection. During the war they did help us, in that where large quantities of gas had to be measured an arrangement could be made between the gas company and the consumer to use an inferential meter of the type which has been mentioned for a certain period, but an arrangement had to be added so that if the volume became less than a certain minimum the meter would cut off. That would never do for household supplies. I believe that the Mond Gas Company have a special Act which enables them to use this type of meter for the measurement of large quantities; but that is outside the scope of our Meters Committee, I think.

The Extras that Mount Up.

Col. W. CARMICHAEL PEEBLES: It seems to me that the Committee have done a great work, and I only trust that all that has been said about getting unanimity will be carried out. We have the lights type of meter, the standard type, the high-capacity and the small high-capacity meter, and the various ranges of prepayment meter, of the single coin type taking a penny or a shilling, the dual type, taking a penny or a shilling, at the option of the gas company, and now the optional meter where the option is with the consumer. In view of this variety you will appreciate how difficult it is to make meters cheaply. With regard to the reference made to the little specialities which certain undertakings call for, you have to remember the workman behind the scenes; he demands payment for all these little odds and ends, and consequently, that brings up the cost considerably. Additions of a penny here and there for little extras soon mount up.

The references to the replies made by the Industry to the questionnaire are interesting, and it would be still more interesting to meter makers to have more information about those replies.

With regard to the standardization of flanges for gas pipes, the Society of British Gas Industries, with the National body, brought out a fresh standard or set of standards, and the result was simply to add another lot of standards to our designs. Now we can never keep a governor stock for general use unless we have the very largest size and then turn it down to suit a particular enquiry. It costs money to make the necessary modifications. It was thought that the Industry would adopt that standard, but it was not so. I hope that in regard to this meters specification something will be done really seriously to get the Industry to act before it goes forward as a national specification.

Mr. T. H. POULSON (Stafford): Recently we have been in the throes of a Municipal Election, and I notice that one of the candidates has really gone to the root of the matter even more than our old friend Mr. Abady. One of the Labour Party has suggested that we should have higher wages, more and better houses, and supplies of gas and electricity paid for inclusive with the rates, on the same system as with water supply, so that there would be no meters, and costs of administration would thus be reduced. I mention that because, knowing the aspirations of that Party, it might be as well to get some Press notices, so that the idea shall not be developed.

The PRESIDENT: We have had an interesting discussion and I think it is particularly appropriate that we have made a start on standardization. It is true that the work of the Meters Committee is only skirting the question of general standardization, and very rightly so, but I do believe that it represents a step in the right direction. I think we are all interested that Mr. Abady should have introduced once again the question of the inferential meter, and I think he probably appreciates that not only we who are engaged in selling gas, but also almost everybody engaged in the manufacture of meters, have been thinking about and applying themselves to the problem of the inferential meter for the past 15 or 20 years, or perhaps even longer. But so far we have always been defeated, with regard to an inferential meter or gas volume recorder, by the difficulty of dealing with the minimum quantity, and, as Mr. Lacey and Mr. Thorp have pointed out, the Board of Trade will never agree to the stamping of a meter, under the provisions of the Sales of Gas Act, if it does not measure correctly within the desired percentages when passing the minimum quantity of gas which could be used by a consumer under any circumstances. There are difficulties also with regard to the larger sizes of meter. Beyond certain capacities there has been a tendency for us to get away from the large wet drum type of ordinary meter. Other types have been introduced—the bell type of meter, the B. and M. type, and many others—and have been adopted for large scale industrial supplies; I am speaking now of the very large quantities which previously had been dealt with only by the standard drum type of station meter. Of course, those types of meters, because they are positive in measurement, can be stamped. While it has been suggested that the Committee should go on with their consideration of standardization of larger types of meter, it will be very difficult, of course, to evolve a standard when we have so many types, some of which under certain circumstances may be more suitable than others, depending on the demand of the consumer and the conditions of pressure, and so on, at which he is supplied. Again, I would point out that I have in mind industrial supplies when discussing this larger type of meter.

Extreme Sizes.

Mr. JOHN TERRACE: I do not think there is any reason for me to reply to the different speakers individually. Some of them have been most helpful, and the remarks of some makers have cancelled out the remarks of others. But I think the President went rather to an extreme when he referred to the larger sized meters; I do not think Mr. Madden was referring to the extreme sizes when he suggested that the Meters Committee should go on to deal with larger size meters. You will notice that the specification deals with meters up to only the larger ordinary size; we found that when we got beyond that there were rather big differences of opinion and we preferred to put forward the specification in its present form in order to see how it would be accepted. If it is likely to meet with approval we should be only too pleased to deal with the sizes of meters next to that. I think that the extreme sizes such as the President has in mind, for large industrial users, would not really come within the scope of a specification that we should draw up.

In connection with the Report, Mr. Madden mentioned several points which would make it much clearer to those who were not aware of what had really been done; and Mr. Bennet again stressed the point and gave you real reasons to enable you to appreciate what it means to ask for a variation from a standard meter. We felt that it was very difficult to put forward a specification which would be accepted if we were to include all these various points, and, therefore, we have left out a tremendous lot of detail.

Another line of argument has been opened up by Mr. Abady, and I am very pleased to hear Mr. Thorp reply to that, because no-one could do so better than he, for no-one has had more experience in this country of the inferential meter problem. Of course, such meters have been used for measuring in works; but the same difficulty crops up there.

It has been suggested by Col. Peebles that it would have been interesting if in our Report we gave all the replies to the questionnaire. I am afraid that if we had done that we should have provoked a tremendous lot of argument which would not have helped the specification forward very much. It was rather interesting, however, to hear just a little of the arguments from Mr. Bennet, but he picked out the best points and the most humorous, and not those about which there is most controversy.

The time may come when we shall be able to tell the people that they can use as much gas as they like, but I am afraid we are rather limited in the supply of gas in the direction mentioned yesterday by one of the speakers at the Research Luncheon. It was stated by one of the speakers there that one could install an electrical apparatus and that one could be absolutely sure that it would not use more than the makers stated it would use. I am afraid that we could not count upon the consumers using absolutely the definite quantities of gas for which an apparatus was set, and therefore, we could not allow them to use gas *ad lib.* and to pay a fixed charge per quarter only.

Institution Gas Research Fellowship Report; 1934-35

The Scaling of Mild Steel in Sulphur-Free and Sulphur-Containing Furnace Atmospheres

By H. C. Millett, Ph.D. (Institution Gas Research Fellow), and John W. Cobb, C.B.E., B.Sc., F.I.C. (Livesey Professor).

In 1929, taken as a good year, the production of steel in Great Britain was approximately 9,500,000 tons, while the average price was £8 per ton, so that in manufacture, the loss of every one per cent. of the metal by scaling would mean a loss of 95,000 tons and £760,000. In gauging the total loss by furnace operations, it has to be taken into account that any steel article in the finished condition has of necessity been heated a number of times, each incurring its own loss. Moreover, the actual monetary loss is much increased from the effect of surface deterioration in necessitating machining (which involves labour and loss of material), from the production of wasters outside specified dimensions, and from the malign influence exerted by a roughened or deteriorated surface on processes in which a coating of another metal has to be applied to the steel.

In the past, many estimates have been made of the amount of scaling undergone by steel in various furnacing operations, by direct works observations, under conditions in which exact control was difficult or impossible, and in which the range of variation in temperature and atmosphere which could be employed was of necessity much restricted. A more systematic and extended survey seemed to be called for and this has been attempted in the laboratories of the University of Leeds in recent years. All our experiments were made upon small samples of the same mild steel which were subjected to the action of different gaseous atmospheres, either "neutral," oxidizing, or reducing, the scaling being measured by the increase in weight of the test piece in each case. The gaseous atmospheres were made up to represent the products of combustion of the different fuels, solid, liquid, and gaseous, which might be used in furnaces. The specific effects arising from the presence of sulphur in the fuels has also been studied and forms the more special subject of this Report, whilst the earlier results obtained by Carrington, Marson, Angus, and Blackburn in turn have been summarized along with the work of others.

As a starting point, the atmosphere employed was nitrogen, in which the scaling effect was quite negligible, a very slight diminution in weight being actually observed. As soon, however, as some of the nitrogen was replaced by carbon dioxide, scaling came into evidence and was definitely more pronounced when steam was used instead of carbon dioxide. An atmosphere was made up of the composition 2 per cent. H_2O, 18 per cent. CO_2, 80 per cent. N_2 by volume to represent the products of combustion of a dry, high-temperature coke burned with the theoretical quantity of air, this being chosen as giving the minimum of steam possible under industrial conditions, and the scaling then obtained was 0·0043 g. per square centimetre of exposed surface (or 0·14 oz./sq.ft.) after exposure for one hour at 1,000° C. Other nominally "neutral" atmospheres were then tried. A fuel containing more hydrogen, such as coal, oil, or producer gas, may be represented by the atmosphere 10 per cent. CO_2, 10 per cent. H_2O, 80 per cent. N_2, and this gave nearly twice the scaling, viz., 0·0073 g./cm.^{2}, while an atmosphere 10 per cent. CO_2, 20 per cent. H_2O, 70 per cent. N_2, representing the products of combustion of coal gas gave an increase in weight of 0·0120 g./cm.^{2} The scaling from what we may call the fuel-oil product (10 per cent. steam) was reduced to the same as that from the coke (2 per cent. steam) by the addition of either 35 per cent. carbon monoxide, 18 per cent. hydrogen, or 12·5 per cent. methane.

For the complete elimination of scaling by the use of reducing gases it was found that to the "neutral" atmosphere containing 10 per cent. steam, an addition of either 29 per cent. hydrogen, 95 per cent. carbon monoxide, or 21 per cent. methane was necessary. These quantities are very large, especially when expressed in terms of their thermal value, and remain so even if the halving of scaling instead of its complete elimination is to be attained. Moreover, the presence of such large proportions of reducing gas would lower the temperature of the furnace to an excessive extent, which indicates that where such complete elimination from scaling is sought, heating by simple and direct exposure to the stream of burning gas is wasteful and often impracticable, and that some other method should be employed.

An interesting observation may be recorded. A hydrocarbon (which caused a smoky atmosphere by thermal decomposition) was added to the "neutral" atmosphere in such quantity as to prevent scaling. The smoky gases leaving the furnace were filtered from "carbon" particles and analyzed, and another atmosphere was then used of the same composition as these exit gases with the exclusion of solid carbon particles. A negligible degree of scaling was obtained. This is perhaps the clearest indication that has ever been forthcoming that the solid carbon particles in a smoky atmosphere have in themselves no appreciable anti-scaling value, and that the anti-scaling effect is derived from the accompanying clean reducing gases, carbon monoxide, hydrogen, and methane.[1]

Experiments were also made by the addition of free oxygen in graduated quantity to the "neutral" furnace atmosphere. Its effect was very pronounced, the scaling for the atmospheres representing the products of combustion of a dry high temperature coke, fuel-oil and town gas over a period of exposure of one hour at 1,000° C. being 0·0340, 0·0365, and 0·0420 g./cm.^{2} respectively for an addition of 2 per cent. oxygen, the scaling without free oxygen being 0·0043, 0·0075, and 0·0120 g/cm.^{2} respectively. The additional scaling induced by the presence of oxygen was the same for all three atmospheres, and the importance of its prevention is obvious. Moreover, while the scaling increases very rapidly with the addition of small percentages of oxygen to the "neutral" atmosphere, the anti-scaling effect of similar small quantities of reducing gases proceeds very slowly, which points to the desirability if scaling is to be minimized of ensuring the combination of all oxygen present before the gas stream impinges on the metal. Observations on the influence of free oxygen

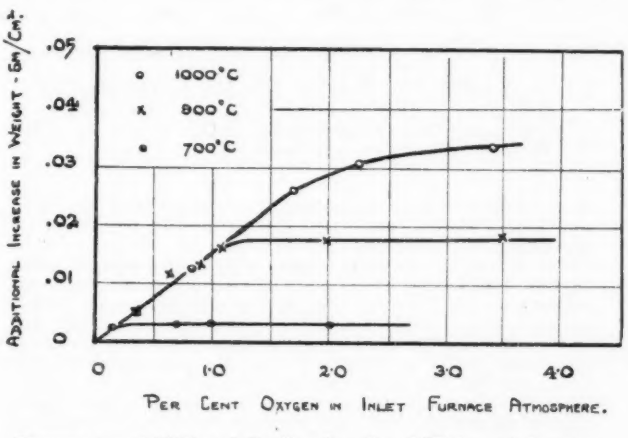

Figure 1.—*Additional Scaling by the Addition of Oxygen to the Furnace Atmosphere,* 10 *per cent.* CO_2, 20 *per cent.* H_2O, 70 *per cent.* N_2. *Period of Exposure, one hour.*

over a wide range of temperature were made because of the importance of this subject, and it is interesting to note that at a relatively low temperature (700° C.), 0·5 per cent. oxygen was sufficient to give a scaling effect which was not materially increased by more oxygen, while at higher temperatures the scaling was not only much greater but increased rapidly with increasing concentration of oxygen (see Figure 1).

It is plainly indicated above that the best results as regards freedom from scaling will only be obtained from a furnace so designed, constructed, and controlled in use that an atmosphere containing no free oxygen and a minimum of steam can be consistently maintained. It is also clear that, although by the exclusion of oxygen and the use of reducing gases such as hydrogen, carbon monoxide, and methane, scaling can be very much reduced, complete elimination of scaling, as is sometimes required, can only be brought about efficiently by indirect heating, in which the bulk of the products of combustion does not come into contact with the metal.

The observations made upon the influence of the sulphur content of the fuel have disclosed some interesting features. It was known from previous experiments made by W. H. Hatfield that the addition of 2 per cent. sulphur dioxide to air had a marked effect in increasing scaling, but our own experiments were directed towards the influence of sulphur in much smaller amounts, such as might occur in the normal combustion of ordinary fuels, and in furnace atmospheres containing little or no oxygen. It was de-

[1] Blackburn and Cobb, J.S.C.I., 1930, **49**, 455 T.

monstrated that even in these circumstances, which are those of practice, the influence of the sulphur compounds is remarkable in its magnitude. It was found, for example, that at 1,000° C., 0·10 per cent. sulphur dioxide in the "neutral" furnace atmosphere, the quantity forthcoming from an average coal, gave the same increase in scaling as 1·0 per cent. free oxygen in any of the three typical atmospheres mentioned above and, therefore, with any fuel. The influence of different quantities can be plainly seen from the curve shown in Figure 2; it is seen there that the scaling at 1,000° C. in the "neutral" atmosphere being 0·0120 g./cm.², that from an added 0·20 per

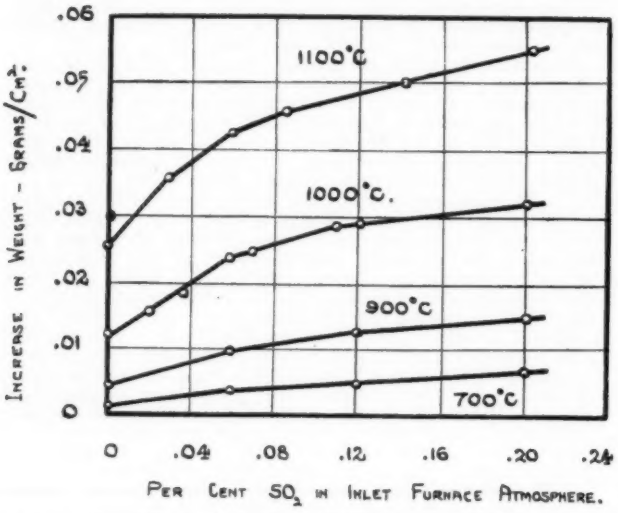

FIGURE 2.—*Effect of Sulphur Dioxide on the Scaling of Mild Steel in the "Neutral" Furnace Atmosphere, 10 per cent. CO_2, 20 per cent. H_2O, 70 per cent. N_2. Period of Exposure, one hour.*

cent. sulphur dioxide, representing unpurified coal-gas, would be 0·0320 g./cm.², and that from 0·10 per cent., representing an ordinary producer-gas or coal, would be 0·0280 g./cm.². A concentration of 0·01 per cent. sulphur dioxide would represent a purified coal-gas retaining 30 gr. sulphur per 100 cu.ft., and this would give only 0·0140 g./cm.², while if the purification were carried much further by the use of the Carpenter-Evans, activated carbon, or benzole washing process, so that the gas contained only 7 gr. per 100 cu.ft., the scaling would be 0·0125 g./cm.². Thus the degree of purification from sulphur compounds effected in normal town gas practice had plainly a marked

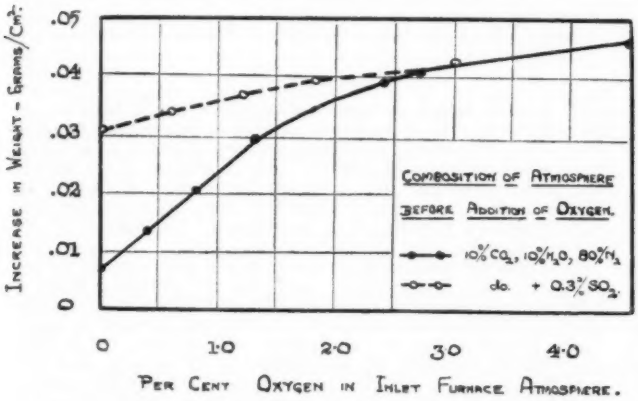

FIGURE 3.—*Scaling of Mild Steel in Sulphur-free and Sulphur-containing Furnace Atmospheres containing additions of free oxygen. Temperature, 1,000° C. Period of Exposure, one hour.*

beneficial effect in almost eliminating the scaling due to sulphur, but there was in these experiments only a slight further improvement effected by more drastic purification.

It may be noted that the curve connecting scaling with sulphur dioxide content rises very quickly up to 0·08 per cent. sulphur dioxide, and afterwards much more slowly. It is an interesting point that the influence of the small quantities of sulphur dioxide investigated was great in a "neutral" or reducing atmosphere, but that it fell in atmospheres containing free oxygen (which are of themselves so scale-producing), and appeared to vanish when the free oxygen reached the figure of 3 per cent. (Figure 3). As regards the influence of temperature it will be seen from Figure 2 that the influence of the same amount of sulphur dioxide is much greater at higher temperatures; for example, with 0·10 per cent. sulphur dioxide the scaling was 0·0045 and 0·0465 g./cm.² at 700° C. and 1,100° C. respectively—a tenfold increase at the higher temperature.

Our observations have been specially directed to the influence of sulphur compounds and other gases as exhibited by the weight of scale produced. There are, however, other more subtle effects exerted on the metal which may at times be all-important as inducing such qualities as "red-shortness." This part of the subject requires much more extended study by microscopy and other methods, which should also throw light upon the unexplored mechanism whereby small quantities of sulphur gases exert so much influence. This branch of the work is more specially metallurgical, and the Alloy Steels Committee of the Iron and Steel Federation, and the Iron and Steel Institute have interested themselves in it. With their co-operation and financial support, work on this side will be continued by Mr. A. Preece, Lecturer in Metallurgy in the University of Leeds, and Dr. G. T. Richardson, who has been appointed Research Assistant for this purpose. It is plain that the survey which we have so far made on a typical mild steel should be extended to the whole range of steels and indeed, when opportunity occurs, to other metals and materials.

Professor J. COBB (Livesey Professor): I think it may be regarded as a sign of the times that this Report is presented to The Institution of Gas Engineers. When we at the University of Leeds began this investigation into the influence of different furnace atmospheres on the scaling of steel we did not even venture to suggest that it ought to come within the orbit of the research work of the Institution. But there has been a considerable development since that time and I think that nowadays, having regard to the importance of the industrial use of gas for metal heating, nobody would question the legitimate position of the Report in the Proceedings of the Institution.

(Dr. Millett also introduced the Report.)

Discussion.

Dr. W. H. HATFIELD, F.R.S. (Firth-Brown Laboratories, Sheffield): I am here this morning as a scientific friend of Professor Cobb and as Chairman of the Alloy Steels Research Committee to which reference has been made. But I see Mr. Ralph Halkett, of the Sheffield Gas Company, in the background, and perhaps that fact may modify in some way the tenor of my remarks, taking them from the ultra scientific plane to the economic plane.

However, I should first like to congratulate your Institution upon this magnificent piece of work by Professor Cobb and Dr. Millett. The subject they have tackled is one of very great industrial importance, of equal importance to the iron and steel industry as to the Gas Industry, and I think we shall all agree that the conclusions which are tabulated at the end of the Report are entirely justified by the experimental work upon which they are based.

The subject dealt with is of very great industrial importance to your Industry if only for the reason that the future of metallurgical operations from the standpoint of heat treatment (re-heating) is really with you gas engineers, provided that you can give your gas to the metallurgical industries on a sufficiently satisfactory plane. During the last two or three years we in Sheffield have increased our consumption of gas very rapidly. I speak of the Firth-Brown and the Firth Vickers Works. We are a big organization and we are quite able to hold our own, but we were dealing with the General Manager of a big gas company who also was quite able to hold his own. Nevertheless, as the result of very interesting and very pleasant negotiations we were able to arrange to take very considerable supplies of gas from Mr. Halkett's Company for major industrial operations; so much so that I think I am safe in saying that at present we are consuming gas obtained from the Sheffield Gas Company at the rate of 300 to 400 million cu.ft. per annum, a very big consumption, in spite of the fact that, although we were very pleasant and very diplomatic with Mr. Halkett, we are still paying considerably more for that gas than for producer gas. Therefore, the extra that we are paying is for advantages of a technical kind which we derive from the employment of the Company's gas. Still, it is worth stating to you gas engineers—I suppose you will say that what I suggest is impossible—that if you could reduce the price to 8½d. per 1,000 cu.ft., or something of that sort, we might consume thousands of millions instead of hundreds of millions of cu.ft. per annum. Hence the importance of the work which is placed before you in this Report. I can say that we employ very effectively and satisfac-

torily, apart from a few teething troubles, a very large volume of your gas in our industrial operations; and we shall employ more. This Report is of equal importance and interest to technical institutions of a directly metallurgical kind as it is to you, and I do not know how far a metallurgical discussion of the merits of the Report would interest you. It is true that some years ago I published some work showing that a high sulphur content will accelerate oxidation and scaling; but I was then dealing in my researches with the possibility of producing steels which would be completely resistant to scaling—and, as you know, we have been very successful in that direction.

Before leaving the economic aspect of things I should like to emphasize that in some localities you gas engineers have become distributors rather than producers of gas, and therefore, it becomes very important that you take an increasing interest, as I know you do, in the composition of the gas that you distribute. I need not go into technical details in that regard.

Town Gas and Furnace Atmosphere Control.

The reason why we are using in our works so much Company gas as distinct from producer gas is that of the facility of control of the furnace atmosphere, the very subject with which Professor Cobb has been dealing. It is true that by properly balancing the air and the gas you can obtain most effectively conditions which produce a minimum amount of scaling. Therefore, the control of the atmosphere compositions is extremely interesting from the point of view of economy to begin with, because you get a greater efficiency if your gases are balanced. Secondly, the amount of scale can be controlled; and lastly, the nature of the scale. Reference has been made to the effect of the composition of the gas on the nature of the scale. In connection with the ordinary commercial steel the nature of the scale is almost as important as the quantity of the scale, and indeed the Corrosion Committee of the British Iron and Steel Federation are spending a great deal of money at the present time on investigating the effect of varying types of scale upon the resistance of the steel to oxidation, regarding the scale as a means of protecting steel from further attack.

I have no critical observations to make on the work of Professor Cobb and Dr. Millett; my colleagues and I think the work has been done magnificently, so much so that our own Research Council is now backing the further extension of the work, and I can only congratulate your Council on their insight in initially supporting this excellent piece of work.

The PRESIDENT: We are glad to have heard Dr. Hatfield's remarks following the very clear and useful summary we have had of this extraordinarily valuable communication which has been given as our Gas Research Fellowship contribution this year. I am glad that Dr. Hatfield referred to the economic position, because this work is of value not only to our friends in the iron and steel industry in enabling them to effect more economies, but also to ourselves in that it means that they can buy our gas at a price at which we can produce and distribute it. Dr. Hatfield has referred to a price of 8½d. per 1,000 cu.ft. He said that the principal reason his companies were using coal gas was that it afforded facility of control. He might have told us that in some instances the saving effected by the substitution of coal gas for producer gas, by reason of the atmospheric conditions alone, in metal and in reduction of metal wastage, was more than the total cost of the fuel. I know that that is the fact in certain processes, not in his works, but I am sure that, to the extent they have gone in the works in which he is interested, they must have instances in connection with high quality and high priced steel where the wastage under bad furnace atmosphere conditions can amount to very much more than the actual cost of the fuel for the heat treatment. Therefore, the importance of this work to our Industry and to the iron and steel industry cannot be overestimated. The iron and steel industry want fuel which will give them an ideal atmosphere and which, as Dr. Hatfield has said, must be easily controlled. We are able to supply that fuel. But we must improve. We are considering, in the Report which has been submitted, possibilities of the improvement of our fuel by the removal of sulphur compounds; and the Reports which have been presented at this Meeting are an indication of progress.

I should like to express on behalf of the Council appreciation of the work of Professor Cobb and Dr. Millett, described in the Gas Research Fellowship Report.

Report on the Generation of Hydrogen Sulphide in Water-Sealed Gasholders*

By The Gas Light and Coke Company and The South Metropolitan Gas Company

Production of sulphides by bacterial reduction of sulphate probably proceeds continuously in most gasholder tanks to a greater or less extent, but is most rapid when the temperature is highest. Nevertheless, contamination of the gas does not always reach a maximum during the summer; more frequently the trouble is most pronounced during early autumn. During spring and early summer bacterial activity proceeds throughout the water in the tank, but hydrogen sulphide only reaches the gas stored in the holder from the surface layers of water. The surface layers of water are warmer than the bulk of the water in the tank and thus the same water tends to remain always on top, imparting hydrogen sulphide to the gas as rapidly as it is formed. If there is an active flow of gas through the holder, unduly high concentrations of hydrogen sulphide in the water or the gas are not reached at this period of the year, although a holder which is little used may prove troublesome. Meanwhile bacteria in the lower levels of the water are producing hydrogen sulphide and storing it either as free hydrogen sulphide in solution in the water or as dissolved or suspended sulphides of metals such as calcium and iron. The total amount of hydrogen sulphide stored in this way may amount to several tons in a large gasholder, but, so long as the surface layers of the water are the warmest, contamination of the gas is but slight. During September the atmospheric temperature falls below the deep earth temperature and the surface layers of water are chilled. They sink to the bottom of the tank and warmer water from the bottom rises to the surface. Convection circulation is thus started and the whole of the accumulated hydrogen sulphide becomes available for contamination of the gas. The black colour assumed by the holder water at the commencement of the trouble is a fairly well-known phenomenon and is due to the presence of suspended iron sulphide. It would, however, be wrong to assume that the sudden appearance of the black colour indicates sudden production of hydrogen sulphide: potential trouble has lain at the bottom of the holder tank for some months. Any satisfactory system of holder treatment must, therefore, take cognizance of the development of hydrogen sulphide at the bottom of the tank and aim at the removal or fixation of this impurity before the circulation of water commences in the autumn.

It is of the utmost importance that, in any case where the generation of hydrogen sulphide in the holder is suspected, the gas entering and leaving the holder, and the water in the holder, should be submitted to precise chemical examination.

METHODS OF PREVENTING OR RELIEVING CONTAMINATION.

Numerous methods of preventing or relieving contamination have been suggested, but for convenience they may be grouped in three classes according to the mode by which the reagent is intended to act.

(*a*) *Oxidants.*

One of the most obvious ways of endeavouring to remove hydrogen sulphide from water is to attempt its oxidation to elemental sulphur or sulphate. This method suffers to some extent from the objection that it restores to the bacteria the sulphates which are necessary for their life processes, although it does compensate for this to some extent by oxidizing the organic foodstuffs present in the water. Nevertheless, methods of this type have served to hold in check contamination of the gas.

Among the reagents suggested as oxidants may be mentioned calcium hypochlorite (chloride of lime), chlorine,

* The description of the methods of testing the gas and water for hydrogen sulphide, given as Appendices to the Report, was published in the "JOURNAL" for July 17, 1935.

and hydrogen peroxide. A similar effect has been obtained by aerating the holder water, that is, circulating the water through apparatus in which it is freely exposed to the atmosphere. This latter method suffers from the disadvantage that the smell of the gasholder water is liable to create a nuisance.

All oxidant processes require accurate chemical control to ensure that the holder water is not rendered unduly corrosive towards steelwork.

(b) Precipitants.

The object of precipitants is to remove from the holder water in insoluble form either the sulphides or the sulphates from which they are formed.

If it is intended to remove the sulphates it is not sufficient simply to precipitate them within the holder tank, for even barium sulphate is sufficiently soluble to enable the bacterial reduction to proceed.

Sulphides have been precipitated by the introduction into the gasholder tank of ferrous sulphate, copper sulphate, zinc oxide, and zinc acetate. The introduction of sulphates is clearly undesirable for the reason that it provides additional resources for the bacteria, and for this reason alone the use of the first two reagents is to be condemned. Moreover, moist ferrous sulphide in contact with coal gas liberates hydrogen sulphide and the addition of ferrous sulphate is therefore of little value. Copper is electro-negative to iron and is thus under suspicion of accelerating corrosion if introduced into the holder water. Zinc, on the other hand, is electro-positive to iron and is thus unlikely to affect the rate of corrosive attack, its sulphide is not decomposed by coal gas, and the addition of the oxide or acetate does not involve the introduction of undesirable acid radicles.

(c) Bactericides.

If it were possible to kill the bacteria in the water the trouble would automatically cease, but up to the present a satisfactory bactericide has not been found. Copper sulphate is effective, but its disadvantages have already been discussed. Phenol is not effective unless employed in impracticably high concentration; naphthalene prevents the growth of bacteria, but must be present in a concentration high enough to impart a considerable amount of naphthalene to the gas. There appears to be some hope that a suitable bactericide may be found amongst the organic dyestuffs, provided the cost is not prohibitive.

A Method of Control.

As the result of several years' experience in the treatment of gasholder water, the following is one method which has been developed and found to be effective:—

The gasholder tank is filled with water of the lowest sulphate content available. If there is no source of supply of water having a sulphate content less than 10 grains per gallon the water is treated externally to the holder tank with barium chloride. The treated water should contain less than 2 grains per gallon of sulphate, barium, or suspended barium sulphate. Make-up water is of similar quality to that employed for filling the tank.

Provision is made for removing water from at least four points equally spaced around the circumference at the bottom of the tank and for returning this water to the surface of the water inside the bell.

Samples of the water are taken at regular intervals from points spaced evenly round the circumference of the tank and from depths corresponding to 5 ft. below the surface, 5 ft. above the bottom, and halfway between these two depths. These samples of water are tested for free hydrogen sulphide, fixed hydrogen sulphide, and, after zinc addition has commenced, for soluble zinc. As soon as free or fixed hydrogen sulphide is found in the holder water in measurable amount, circulation of the water is commenced, zinc oxide paste being added to the returning water in such quantity and for such a period of time as suffices to precipitate all sulphides and leave a slight excess of soluble zinc. Circulation is then stopped, but the regular periodic testing continues. So long as soluble zinc remains present in the holder water, no hydrogen sulphide can be present, and a decrease in the amount of soluble zinc towards the zero point is the signal for re-starting the pumps and zinc addition. When it is desired to minimize the accumulation of solid precipitate in the tank, hydrogen peroxide may be used in place of zinc oxide and the same method of addition employed.

Mr. H. Hollings introduced the Report.

The President: There do not appear to be any speakers, but I had hoped that there might be some members desirous of giving us the results of their experience and investigations. This Report is one that is very much needed and has been repeatedly asked for. The suggestions contained in the Report for control are invaluable and, I hope, will be carried out by every gas undertaking. The damage which we suffer by the presence of a small amount of sulphur compounds is relatively small compared with the damage to the reputation of gas supply that is caused by the slightest trace of sulphuretted hydrogen and therefore this question of the contamination of gas in water-sealed holders is of vital importance to everybody. We are very much indebted to the Gas Light and Coke Company and the South Metropolitan Gas Company for placing at the disposal of the Industry the results of their investigations into this very important subject.

Mr. F. P. Tarratt (Newcastle-upon-Tyne): It might perhaps interest you to know that I had this trouble at Newcastle three or four years ago with regard to contamination of a holder, and, although we ultimately got rid of it, if we had had the benefit of this Report at that time we should have got rid of it much sooner, and without suffering in the way we did. The holder had been in operation for 30 or 40 years and we laid it off for overhaul. The tank was then filled with town water and immediately the holder was brought into use again, H_2S was showing at the outlet. That continued for some time and it was only by constant charging of the gas through the holder that we were able to clear the H_2S. If this Report had been before us at that time we should have found it extremely helpful and I cannot help but think there must be a large number of members in this room who had similar experience and who will greatly appreciate the facilities that are now placed before them for getting over this difficulty.

Mr. J. H. Clark (Whaley Bridge): About 18 months ago we took down a double spiral holder, the top being taken off in order that we might redesign the two lifts and keep the existing tank. Just beyond our works is a bleaching works, 500 yards away on a stream which passes by. I was very disturbed about pumping the water from the stream for fear it might possibly be contaminated by the bleaching work. Therefore, I ran a 4-inch pipe 600 yards up the stream and took the water from the virgin stream. On filling the holder and letting it stand for 24 hours the water was definitely black. We then proceeded to analyze the water and we also called in the services of I.C.I., but we have decided to empty the tank and replace it with water that is treated as it goes in. My mistake was, in filling the holder, that I overlooked the existence of isolated farms en route up to the gathering ground. These were a source of pollution and the problem was definitely a bacterial one.

Generation of H_2S in a New Holder.

Mr. D. B. Parkinson (British Gas Light): We have recently, at the small works with which I am connected, had a little of this trouble. The Engineer telephoned me to say that his gas was showing signs of discoloration on the outlet although his purifier outlet was completely clean. Actually he was getting a distinct discoloration in about 1½ minutes. We were fortunate enough to be able to obtain the advice contained in this Report and we have made use of it The holder was a new one having a capacity of 100,000 cu.ft. We put about ¾ cwt. of chloride of lime into the water and at the same time we tried aerating the water by having two pump suctions going down to within about a foot of the bottom of the tank and then spraying the water on to the bell. The Engineer continued this until he calculated that the water had been changed twice and in about 48 hours the trouble began to clear itself quite perceptibly and I heard from him only yesterday that there is now no trace at all at the outlet. Strangely enough the pump from these works also goes to a holder station about 4 miles away where there is an identical holder which was built simultaneously with the one about which I have been speaking, but no trouble whatever has been experienced with this second holder.

Dr. G. E. Foxwell: I am only speaking because I think it is a pity that such an excellent Report should not be more fully discussed, not that I have been in a position to have experience of this sort. It seems to me that it must be a rather curious type of bacteria which is only poisoned by naphthalene, and I wonder if Mr. Hollings could say something about that. When he takes the naphthalene out it appears that he gets trouble. In this connection it seems to me a matter of some interest that we always take out everything we want to take out in front of the holder, but why not do this after the holder? There would probably be a little trouble with variations of flow, but that should be capable of being overcome and we should not have to do many things we have to do to-day in our chemical processes. Can Mr. Hollings say anything about the type of bacteria which is causing this trouble?

Mr. E. V. Evans (South Metropolitan Gas Company): I

am not quite sure that we have a name for this bacteria, but it is one of the sulphur series. As to this being a bacterium which is only acted on by naphthalene, Mr. Hollings of course was quite clear about this, that he wants very large quantities of naphthalene to do it. There are other bactericides such as phenols, but the quantity would be abnormally large and up to the present we have not found any other bactericide that will destroy the bacteria without, at the same time, destroying the gasholder.

1st Report of the Research Executive Committee; 1934-35

The first Arthur Duckham Research Award will be made this year on the recommendation of the Arthur Duckham Memorial Fund Committee constituted by the Trust Deed. It is estimated that the gross income of the Fund will be approximately £365 per annum.

The Library of the Institution has been entirely equipped with steel shelving, giving considerably more shelf accommodation for a continually increasing number of accessions and facilitating the subject classification and storage of the volumes. The Research Executive Committee has under consideration a Scheme for the regular monthly issue of Abstracts of Current Gas Literature on subjects of interest to the Gas Industry in all its technical aspects. It is felt that no single publication at present supplies this information and that such Abstracts would be of considerable use, as would the contemplated compilation and publication of a Summary of the past Research Work of the Institution.

Investigations.

Three Research Chemists and five Research Assistants were retained during 1934-35 in connection with Leeds University for the conduct of the investigations described in the Reports of the Joint Research Committee and the Liquor Effluents and Ammonia Committee. The Gas Research Fellow has carried out investigations throughout the year at Leeds University under the direction of the Livesey Professor. Researches of practical interest to the Gas Industry continue to be conducted at the Laboratories of the British Refractories Research Association, under the guidance of the Refractory Materials Joint Committee. These various researches and the work of the other Technical Committees responsible to the Research Executive Committee are summarized in this Report.

The investigations of the Joint Research Committee and of the Liquor Effluents and Ammonia Committee are being continued, with the exception of that relating to the Carburetted Water Gas process, which is completed. The Research Executive Committee has under consideration the initiation of research into, *inter alia*, (i) the problem of the deposition of gum in gas distribution systems and (ii) the removal of organic sulphur compounds from town gas, including purification to an even greater degree than is at present normal and the effect of such purification on the properties and performance of the gas.

Close contact is being maintained with technical developments at home and overseas, amongst the subjects in course of investigation being the German processes for (1) complete gasification under pressure using oxygen and steam, (2) the synthesis of motor spirit from water gas and (3) the removal of carbon monoxide from town gas. This process for the production of "non-poisonous" (CO-free) town gas, the significance of which has been exaggerated in the Daily Press, was amongst the matters investigated by the Technical Assistant Secretary during a recent visit to Germany. His report showed that, whilst the removal of carbon monoxide from town gas can apparently be carried out effectively, the process cannot be operated without involving additional costs. The results obtained on the large experimental Plant at Hameln have been secured under economic conditions which happen to be exceptionally favourable to the process. It appears unlikely that the erection of large-scale plant in Germany will be voluntarily proceeded with to any considerable extent until the economic side of the process is more encouraging.

The Institution of Gas Engineers is supporting by subscription the investigations of the Association of British Chemical Manufacturers into Methods for the Detection of Toxic Gases in Industry. The object is to standardize suitable methods, not so much of great analytical precision as of general and rapid applicability, for the purpose of detecting the presence of toxic gases in concentrations which might be physiologically harmful to workers. Methods, some of which are being tried out under practical conditions by certain Gas Undertakings, have so far been evolved for detecting Ammonia, Benzene, Carbon disulphide, Carbon monoxide, Hydrocyanic acid, and Hydrogen sulphide, occurring in the manufacture of town gas. A second phase of these investigations is concerned with an examination of gas masks and respirators suitable for use in the presence of the above toxic gases.

Gasholder Committee.

The Committee is giving the closest attention to the important question of the inspection of Gasholders for the purpose of detecting internal corrosion. Various types of apparatus for determining the thickness of the sheeting without the necessity of entering the holder are being tested by the Committee, which is conferring with the Home Office on the whole subject of internal corrosion, on which it will submit a Report to the Council for the guidance of Gas Engineers.

Attention is again directed to the necessity for the adequate inspection and maintenance of Gasholders and the keeping of a systematic record thereof, as recommended in the 1st Report of the Gasholder Committee; The Inspection and Insurance of Gasholders (Publication No. 53, 1932), which related to the external inspection of Water-sealed Gasholders. It will be extended, as above-mentioned, to cover the internal inspection of Water-sealed Gasholders and to deal with the external and internal inspection and maintenance of waterless Gasholders.

The Gasholder Committee has considered the circumstances of an accident at Barrow-in-Furness on 17th January, 1935, involving a rope-guided Gasholder, over 50 years old and of 400,000 cu.ft. capacity, and of a fire at Wapping Gas Works on 26th January, 1935, which resulted from the fracture of a 15-in. gas main caused by the collapse of a tower scrubber. A member of the Committee immediately visited the scene of the accident at Barrow-in-Furness and reported thereon to the Committee, supplementing his report with specimens of the sheeting involved.

Voluntary Rules to be observed in the Repair of Water-sealed Gasholders have been issued, on the recommendation of the Gasholder Committee, by The Institution of Gas Engineers with the approval of the Home Office and the Society of British Gas Industries. They form an Appendix to this 1st Report of the Research Executive Committee.

Pipes Committee.

Agreement has been reached with the Engineering Department of the General Post Office concerning (1) the notification of serious gas leakages likely to damage Post Office plant and/or injure Post Office workers, and (2) access to Post Office manholes by Employees of Gas Undertakings. The publication of Memoranda concerning the Palladium Chloride Detector for Carbon Monoxide and Methods for dealing with Escapes of Gas into Cable Ducts and Boxes, is under consideration.

Attention is directed to the Contributed Report on Protective Coatings for Underground Pipes summarized herein.

Purifiers Committee.

The Committee continues to collect, collate, and examine data relative to the operation of purifiers and the use of electricity in purifier houses, and is preparing, in conjunction with the Home Office, a Memorandum indicating generally the procedure and precautions to be observed for the avoidance of explosions, fires, and personal injuries. The number of accidents continues to be relatively negligible.

APPENDIX.

VOLUNTARY RULES TO BE OBSERVED IN THE REPAIR OF WATER-SEALED GASHOLDERS.

Issued by The Institution of Gas Engineers with the Approval of the Home Office and The Society of British Gas Industries.

1. Before opening the Gasholder, it should be completely isolated, on both the intake and offtake pipes, from other gas systems, by severing the mains and blank-

ing them on both ends, or by closing the valves and water-sealing both pipes, care being taken to ensure that the water-seals are continuously maintained.

2. The Gasholder should be completely freed from gas, taking care to release the imprisoned gas in the grips and any other confined space. No naked lights, matches, or lighters should be allowed where they are likely to prove a danger.
3. The expelling of final traces of gas should be done by blowing air through the Gasholder, and the blowing should be continued until the last traces of gas are removed and subsequently resumed while men are working in the Gasholder. (See Rule 7.)
4. Where water is to be removed from the tank, care must be taken first to take off the Manhole Covers.
5. All oil should be removed from the surface of the water. When repairs are carried out with water left in the tank, it is desirable to replace a certain quantity of the upper water with fresh water.
6. Where any sheets are to be removed from a Gasholder, even after the Gasholder has been cleared, only a hammer and chisel should be used, and there should be a good supply of oil or water immediately available to moisten the chisel so that sparks may be prevented while rivet heads are being cut off. Such sheets should be removed by cutting the rivet heads and wedging the seams apart by means of hardwood wedges.
7. Before any man enters the holder, advantage should be taken of all openings in the crown to ensure that the Gasholder is completely cleared. Tests for gas should be made to ascertain that the atmosphere in the Gasholder is safe for men to work in, which can be ascertained by lowering a cage of mice into the Gasholder. (See Rule 3.)
8. The air box through which the men enter the Gasholder should be fixed either above, or near to, the pipe through which the air is blown in, or on to the inlet or outlet pipe if large enough to allow of entry. In the latter case, air should be admitted through the pipe on which the air box is fitted.
9. Wherever possible, at the water level, there should be two rafts, one permanently moored for landing at point of entrance, and the other provided for movement round the Gasholder. Each raft should be provided with a lifebuoy and boat hook.
10. Workmen should never enter the Gasholder without taking with them a cage of mice, which should be kept under observation so that if there is any evidence of gas the men may at once withdraw.
11. Whenever men work in a closed Gasholder, a man should be stationed directly outside the air box and provided with two sets of breathing apparatus and with life lines. The man should be in a position, in case of emergency, to summon necessary assistance quickly. By breathing apparatus is meant, either a self-contained oxygen breathing apparatus or an apparatus of the Burrel canister type specially designed to protect the wearer against low concentrations of carbon monoxide.
12. The workmen should be instructed to signal by means of knocking by the hammer, or other suitable means, to indicate they do *not* require assistance. Suitable provision should be made for the safe removal of injured workmen.
13. A suitable mixture of oxygen and carbon dioxide and means for its administration should be immediately available and a competent man trained in the use of such reviving apparatus should always be available. There should be immediately available a properly warmed room equipped with the necessary requirements for rendering First Aid in case of gassing.
14. Only lamps of a type which has been approved for use in fiery mines should be used inside Gasholders if naked lights are dangerous.

Introduction.

Mr. FRANK P. TARRATT (Chairman of the Research Executive Committee, 1934-35), introducing the Report, said: It is necessary for this Report to be presented to you in a very formal manner to-day, and I feel it is incumbent upon me to make a few remarks with regard to it. The Report carefully portrays the work carried out by the various technical committees and the research staff; it is not intended to discuss the Report at this juncture, but it is more than likely that many members who are present this morning may not be with us to-morrow afternoon, when the Report will be submitted to general discussion. I would like, therefore, to refer briefly to some of the principal features of it.

The first point I would mention is that the Duckham Research Award will be made this year, the fund providing the handsome sum of £365 per annum; it will be a lasting tribute to the memory of the late Sir Arthur Duckham and takes a form which I feel would have appealed to him greatly.

You will observe that it is the intention of the Committee to proceed with the abstracting of current gas literature and to prepare a summary of past research. I would like to refer you to the objects of the research organization and to acknowledge the assistance that is being rendered to the Committee by the services of Dr. Braunholtz. You will observe also that work has been carried out by the various technical committees during the year. Among the subjects dealt with by the Committees are the presence of gum, the reduction of organic sulphur compounds, the process for the production of "non-poisonous" town gas, corrosion from the products of combustion of gas; and there is a further report on water gas plant. I must not omit the summarized Report on Street Lighting, which I think is very valuable.

I should like to take this opportunity of expressing my sincere thanks to the members of the Research Executive Committee who have given me such loyal and material assistance during the year.

I now have pleasure in submitting this Report to you and formally move its reception.

Presentation.

The PRESIDENT: We will now take the general discussion on the First Report of the Research Executive Committee (Communication No. 120), and secondly Gas Research and Investigation. This discussion is intended for the consideration of matters referred to in the First Report of the Research Executive Committee and not dealt with in the separately published Reports for which time for discussion has previously been provided during this Meeting, and secondly for the review and general discussion of, and the submission and consideration of, proposals for Gas Research and Investigation and Technical Work. I call upon Mr. Tarratt to present the First Report of the Research Executive Committee.

Mr. F. P. TARRATT (Newcastle-upon-Tyne): The Research Executive Committee is, as you know, a new Committee formed twelve months back for more or less the control of the research operations carried out by the Institution and it took the place of the Joint Research Committee. I referred in some detail yesterday to various investigations that have been carried out and also to one or two matters that we have in mind at the present moment. You will notice from the Report that it is a little more lengthy than the previous Reports, and it probably goes into a little more detail, but it is on much the same lines. We also have to report what has been done by the Joint Research Committee in connection with the Leeds University and the various technical committees which are operating, such as gas appliances, gasholders, joint lighting, &c., and their work is clearly set out. Of course, most of the subjects which these Committees have been dealing with have been dealt with during the Meeting. This afternoon I understand we are meeting for the purpose of discussing this Report, and in discussing it we ask you freely to criticize it and be as helpful to us as you can and not to be destructive. We have on the new Committee, if I may say so, a very well selected number of members. There was a vacancy left on the Committee when it was appointed last year and during the year Mr. Masterman was selected to fill that vacancy, so that we now have the full complement of members. Speaking from the experience I have had as Chairman of the Committee during the last twelve months I can assure you that whatever criticisms you make will be welcome. I should like you clearly to understand that as a Committee we are working as hard as any Committee of the Institution. We have met fairly frequently, as frequently as it is possible for men with many other engagements and who are situated a long way from London. It is nothing unusual for me to travel five hundred or six hundred miles to attend an Executive Committee Meeting but the Committee has been very helpful to me and has endeavoured to arrange the Meetings to meet my wishes as far as possible.

It is early yet to speak of what this Committee can do. We have shown in the Report what we have done. We have to go before the Advisory Committee immediately after this Meeting—I suppose the Advisory Committee will meet in the course of the next week or two—and that Committee will criticize our work and will I hope make helpful suggestions to us. That Committee is a very widely selected one and the greatest care has been taken in electing its members because we feel in that way we shall be able to carry forward the research work of the Institution

in a manner which will be beneficial to the Industry and satisfactory to the members of the Institution.

Effects of Stray Currents.

Dr. W. Beck (Warsaw): I am pleased that the necessity of my being in Paris and London in connection with the Commission Mixte Internationale dealing with corrosion has rendered it possible for me to attend this Meeting.

I would like to state that since the 1933 Meeting, when I last had the pleasure of addressing you, I have moved from Berlin to Warsaw, where I am the Chief of the Department of Corrosion Research at the Institute for Physical Chemistry of the University of Warsaw. Having read the Report on Protective Coatings by Messrs. Densham and Smith, I feel called upon to make some comments on this Paper from a scientific standpoint. In 1933 I had the honour of reading before you a Paper on Electrolytic Corrosion of Gas Mains. Since then I have continued my study and research on this subject. It is very difficult to reproduce in the laboratory the conditions and effects of stray currents as found in practice. I have been working on this subject for a long time, and I intend to publish soon the results of a new technique which I have worked out and which shows the complex character of this subject.

I am particularly interested in the remarks made by the Authors about Plastic Bandages and what they call Adhesive Bandage "C." I would state that in this bandage there is a definite colloid system comprised of proto-paraffins, inorganic fillers, and water. I have confirmed this by some of my recent work. I agree that most organic colloids are destroyed by bacteria when in contact with moist soil, but this does not apply to proto-paraffins, and also not to the previously mentioned colloid system, and I may mention that substances like proto-paraffins are, as far as we can tell, completely unaffected by soil bacterial action. The Authors lay emphasis on currents passing through the bandage, but the "C" Bandage is not in itself intended for use as an insulator when in contact with moist soil, but though we have no insulation in the electro-technic sense it does prevent corrosion. For this reason the Authors' tests in this connection cannot be considered as being of importance with reference to the corrosion of underground mains.

There are certain conditions appertaining to the question of rotting which I do not desire to mention, but I would say that one must not consider this rotting is against the use of the bandage. It is without doubt advantageous to eliminate the capillary action by which water is sucked up through the fibres of the fabric and brought near to the metal surface, but it will never be done by extending the life of the fibres, but, on the contrary, by shortening it as far as possible.

As already mentioned, the question of the electrical resistance of the "C" Bandage in the earth without impressed current is unimportant; the excellent work done in America by Messrs. Gordon Scott and Scott-Ewing has given the same results, thereby confirming by corrosion observations in practice what has been done by myself and my co-workers in the laboratory. These prolonged tests carried out on a large scale prove the great anti-corrosive value of the "C" Bandage, while a large number of other protective media which were similar to some of those tested by the Authors did not prevent corrosion in the earth over the long period. Measurements of the conductivity of the "C" Bandage with impressed current are of little consequence, because where stray currents are anticipated the bandage should be reinforced with additional coating, as is recommended by the makers.

I trust it was fully understood that the comparative test figures given in my 1933 Paper related to the Denso-Tube, which, as I stated, is a tube protected with "Denso" and a coating of special bitumen which is still plastic at room temperature. The total thickness is about 4 m/m. "Denso" alone would not stand up to such test conditions as used by the Authors, and where stray currents come into question a bituminous coating should always be used, but it must not be inferred that the bituminous coating alone forms the anti-corrosive medium, as numerous tests have shown me that without the "Denso" Bandage the protection is insufficient. This I also demonstrated in my 1933 Report.

The use of the "C" Bandage reinforced with an outer coating has been found to give a good and durable protection against stray currents. This was confirmed in the 1932 Report of the Commission Mixte Internationale pour les Experiences Relatives à la Protection des Lignes de Télécommunication et des Canalisations Souterraines.

Presence of Chlorides and Sulphates.

Mr. H. M. Ridge (H. M. Ridge & Co.): As a Chemical Engineer I am greatly interested in the Paper by Messrs. Densham and Smith because I have had a great deal to do with corrosion problems in various parts of the world as well as at home.

Stray currents are important, but are not by any means the only cause of corrosion. Small electric couples are a frequent source of trouble, but are generally difficult to trace and prove. In some places I have found that the presence of appreciable amounts of chlorides and sulphates causes acute corrosion. The search for a suitable remedy has led to trying out many ideas, but it is essential that the remedy be easily applied and be as permanent as possible. Saturated hydrocarbons of suitable composition appear to promise the best success. Kauri gum seemed ideal except for the difficulty of application and its price, but some that was applied 22 years ago was quite recently still in good condition.

Later I came across what I think must be the adhesive bandages "C" and "D" referred to by the Authors. I need not deal with the latter, but on reading the Paper in "Gas Journal," I decided to carry out some check tests, because the very definite results claimed in the Paper were contrary to my experience.

I used 3 ft. lengths of 1 in. gas tubes, some of which were bent hot to an angle of 90° while others were cut in the middle, screwed and connected with an elbow to get a right angle. They were wrapped with "Denso" bandage, placed in a 2 per cent. common salt solution in a metal tank which was insulated from the bench so that the open ends of the tube projected out of the bath. Terminals from a 6 volt direct-current supply were connected to the tubes and the vessel. This test has now been going on for 25 days without a sign of any current passing, showing that under these conditions the resistance is high; it appears to be infinitely high. The figures in table 6 show an extraordinary discrepancy with my results, and I am anxious to find the explanation. In the circumstances I telephoned the Institution, and am here to-day as a visitor to hear what is said about this Paper, which is written under the aëgis of the Gas Light and Coke Company. I have studied a good deal of literature on this subject, but in view of what has been published, and of my own experience, I feel distinctly doubtful as to whether some of the definite statements contained in the Paper can be substantiated and upheld.

I would also like to ask about the details of the methods employed to determine the rotting of the fabrics. It seems to me that this presents some difficulty, and I would greatly appreciate any information about the tests. Surface tension plays an important rôle in corrosion. I suggest that from this point of view a plastic saturated hydrocarbon of low surface tension should be best. It is adsorbed by the surface of the metal tube and is to a high degree inert to chemical attack and to electric currents.

As a final point, and one which is not mentioned in the Paper, the cost has to be considered. Allowing plant to be corroded away is certainly the most costly method, but I am so frequently asked what the cost will be that I think this matter should be mentioned, particularly as the pitch troughing as advocated by the Authors is expensive.

I regret that I cannot see eye-to-eye with the Authors. I hope the matter can be cleared up. It seems possible they will desire to revise their opinions.

Information on Two-Part Tariffs.

Mr. C. Chester (Swindon): I am not going to address my remarks in the way of criticism of the excellent reports we have had at this Research Meeting, because I have made quite a lot of use of the Research Reports which have been previously reported to these Autumn Meetings. It is rather in respect of a new line of research which perhaps comes under the second half of the discussion on this Report that I would like to speak. I remember it was something like twelve months ago, at a meeting of the British Commercial Gas Association, in which a President took a very prominent part, that Dr. E. W. Smith—whom we all admire and are very sorry to see he is not in his usual place here to-day—made a very pointed remark which was never answered. He asked whether the Industry was fundamentally sound. That led me to think, since we were discussing at that Meeting two-part tariffs and electrical competition, whether The Institution of Gas Engineers, as a technical body, had taken its full part in providing technical data for the Industry to base its two-part tariffs and other matters upon. I know Mr. McLusky and Mr. Haynes fairly well, and I know they have had from time to time students approach them for their views on the economics of the Gas Industry, and this rather brings me to the point as to whether or not this Institution might well take up the opportunity which I think presents itself very pointedly to-day for a study of the economics of the Gas Industry, the opportunity to lead and guide our commercial activities in the Industry with the knowledge which the engineers possess on the technical difficulties we

have to face from time to time in building up load factors which as you know—and we have often heard our President reiterate the point—are closely bound up with tariffs. We have to look to the gas engineer for the basis of these tariffs, but it is rather a pity that we have to study the economics written by the electrical industry on which to base our two-part tariffs. I have studied during the last year or two in my leisure hours the economics of all the industries supplying utilitarian commodities to the public, and it was only in a study of the electrical problem that I found any basis on which to build the tariff which I am just putting into operation. I do think that the Institution should give a lead to our other bodies by setting up a Research Committee to investigate and amplify the 1928 Report of the National Gas Council.

The PRESIDENT: Mr. Chester has rather anticipated the opening of the second part of this discussion, but I was really asking if there were other speakers who wished to discuss matters directly arising from the First Report—*i.e.*, matters referred to in the First Report of the Research Executive Committee which had not already been discussed at this meeting. That is the purpose of the first part of our discussion. Mr. Chester has raised a point which, while it might suitably be discussed at our summer meeting, does really not come within the purview of research and the research work of the Institution. While one appreciates that economics are a science and the economics of our Industry require scientific investigation, yet it is hardly a matter for this Research Meeting, but for Mr. Chester's information I might say that following on the work that has previously been done by the National Gas Council there is in process of production a further publication which will shortly be distributed by the Committee set up by the Joint Co-Ordinating Committee on methods of investigating and setting up tariffs.

Mr. T. F. E. RHEAD: Before commenting on the Report I wonder whether we can send Dr. Smith, who has been ill now for five weeks, a message of sympathy. I feel we have missed what would have been a stimulating discussion had he been here. (This suggestion met with the hearty and sympathetic approval of the meeting.)

I have only one point to refer to in connection with this Report and it is in regard to the voluntary rules to be observed in the repair of water-sealed holders. No. 14 says, "Only lamps of a type which has been approved for use in fiery mines should be used inside gasholders if naked lights are dangerous." I want to ask the Committee if they think that lamp is really good enough for gas and air mixtures and whether they have considered that point.

The PRESIDENT: If there are no other speakers wishing to discuss the first part of the First Report of the Research Executive Committee I will ask Mr. Densham, who is one of the authors of the Paper on Protective Coatings, if he will kindly reply, as he has intimated he will be pleased to do so.

Proto-Paraffins and Colloidal Materials.

Mr. A. B. DENSHAM: With regard to Dr. Beck's comments, I quite agree that proto-paraffins are not likely to rot as much as certain other colloidal materials. When we actually buried this Bandage C underground and dug it up a few months later we found it more or less resembled wet blotting paper. It all seemed to be falling to bits. That was in a wet soil. In the same way when we kept it in the laboratory buried in earth we got the most extraordinary fungi and other things growing on it, and there was a great deal of rotting going on. With regard to the question of the insulation of corrosion, it is quite possible, of course, to have a coating which protects perfectly against corrosion but which is not an insulating material. For instance, if you platinum coated a pipe presumably it would be quite a good conductor, but also the platinum would still be a good protector against corrosion. I think it is fairly clear from the tests dealt with in the Report, however, that there is a co-relation between the resistance of ordinary commercial coatings and their power to protect against corrosion. Dr. Beck also raised the question of the rotting of the bandage and suggested that it was best for the material supporting the bitumen, or the inert material, to rot as soon as possible so that there would only be the inert material left. I cannot entirely agree with that. I should think that if the bandage rotted away there would be little channels left through the other material for water to penetrate. Then Dr. Beck suggests that to get the best results it is not enough to use the Bandage C alone but that it should be protected outside with bitumen. We have found that we get quite good results with bitumen without the Bandage C, so that there does not appear to be any reason why we should use that underneath.

With regard to Mr. Ridge, he finds that he gets quite different results when testing this Bandage C in the laboratory after 25 days in a 2 per cent. solution of common salt; he gets no decrease in resistance. We find, when doing it in the laboratory, that we get pretty high resistance for about a fortnight and after that the resistance begins to fall. That was with ordinary tap water and I am just wondering whether this question of rotting may not have something to do with the difference; whether the 2 per cent. salt solution might not be a sort of sterilizing medium which would prevent the rotting occurring. I do not know whether that is a reasonable suggestion, but I should be very interested to hear whether the resistance continues to stay high after 25 days or not and whether in a few weeks the resistance will fall down again as we found in our experiments. Mr. Ridge also asks how we do our tests of rotting. I admit that they were to a certain extent arbitrary. We considered that cellulose was the main component of all the fibres used, and we estimated the amount of cellulose in the fibre or in the coating before the rotting began and then we immersed the pieces of the coating in filtered soil water and incubated them at about 23° C. for varying periods and estimated the amount of cellulose left. Of course, there are other components of coatings than cellulose, but we just did that because it seems to be the easiest thing to estimate, but more than 50 per cent. of the fabrics we investigated did consist of cellulose. With regard to the surface tension of the plastic saturated hydrocarbons, I quite agree that a hydrocarbon with a low surface tension does wet the paper better, but if you use bitumen or pitch it is only a question of getting it hot enough to lower the surface tension and then it will bind quite well on the pipe, especially as the pipe is pre-heated with some kind of green oil or something to bind it on, although that is not really necessary if you get the pitch or bitumen hot enough.

I do not know if I may raise two minor points that people have written to me about. The first is with regard to Table 7 giving the order of merit of the coatings from the appearance, and in Clause 3 on the following page where we give our conclusions. I have given D and B with insulation tape. That is meant to be one coating. It is not D with insulation tape and B with insulation tape as two coatings and it should have been given as D and B together with insulation tape. That has apparently caused some confusion.

In Table 8 on the same page there is a list of the coatings with the average resistance in ohms per sq.ft., &c., and somebody has suggested that that was supposed to represent the relative merit of the coatings. For instance, the 2 million ohms resistance per sq.ft. was four times as good as the 500,000 ohms resistance per sq.ft. and 200 times as good as the 100,000 ohms resistance per sq.ft. That is not at all what we intended. What we meant was that any coating that was over, say, 20,000 ohms per sq.ft. was good but because the resistance is three or four times as high it does not mean that that material is three or four times as good. It means that they are of the same order.

Efficiency of the Utilization of Gas.

The PRESIDENT: We will now proceed to the General Discussion of Gas Research and Investigation. In looking forward to the work that is before us, I feel sure you will be pleased to hear that the research work which is directly concerned with the efficiency of utilization of gas, which has been carried out in connection with the Gas Research Fellowship Report, is to be continued during the present year and that in collaboration with the Iron and Steel Institute. There is no doubt about it that all research which is directed to the higher efficiency of utilization is of paramount importance, and those of us who have had any work to do shall I say in the last few years in the design and setting up of industrial utilization furnaces and appliances appreciate the necessity for this work and particularly on furnace atmospheres. Electricity has been trying particularly to gain a hold of a certain kind on furnace work by the utilization of special atmospheres producing butane, ammonia, &c., and so far as that work is concerned it has enabled them to compete in some of the smaller uses. In such matters as bright annealing of metals where prior to the production of artificial atmospheres they were not able to compete at all, electricity is now able to compete. Of course on the larger scale even with prepared or artificial atmospheres electricity has not been able to compete at all on account of price, and I do hope, therefore, that we will extend our research in utilization not only in the production of proper atmospheres to secure greater efficiency and a better product but in matters of improving heat transference. I am finding that there are more and more fields open for low temperature heat work with gas and there are great possibilities for the extension of our business in low-temperature industrial work. There are problems of heat transference at low temperatures which must be investigated, and when I speak of low temperatures I am speaking of something less than

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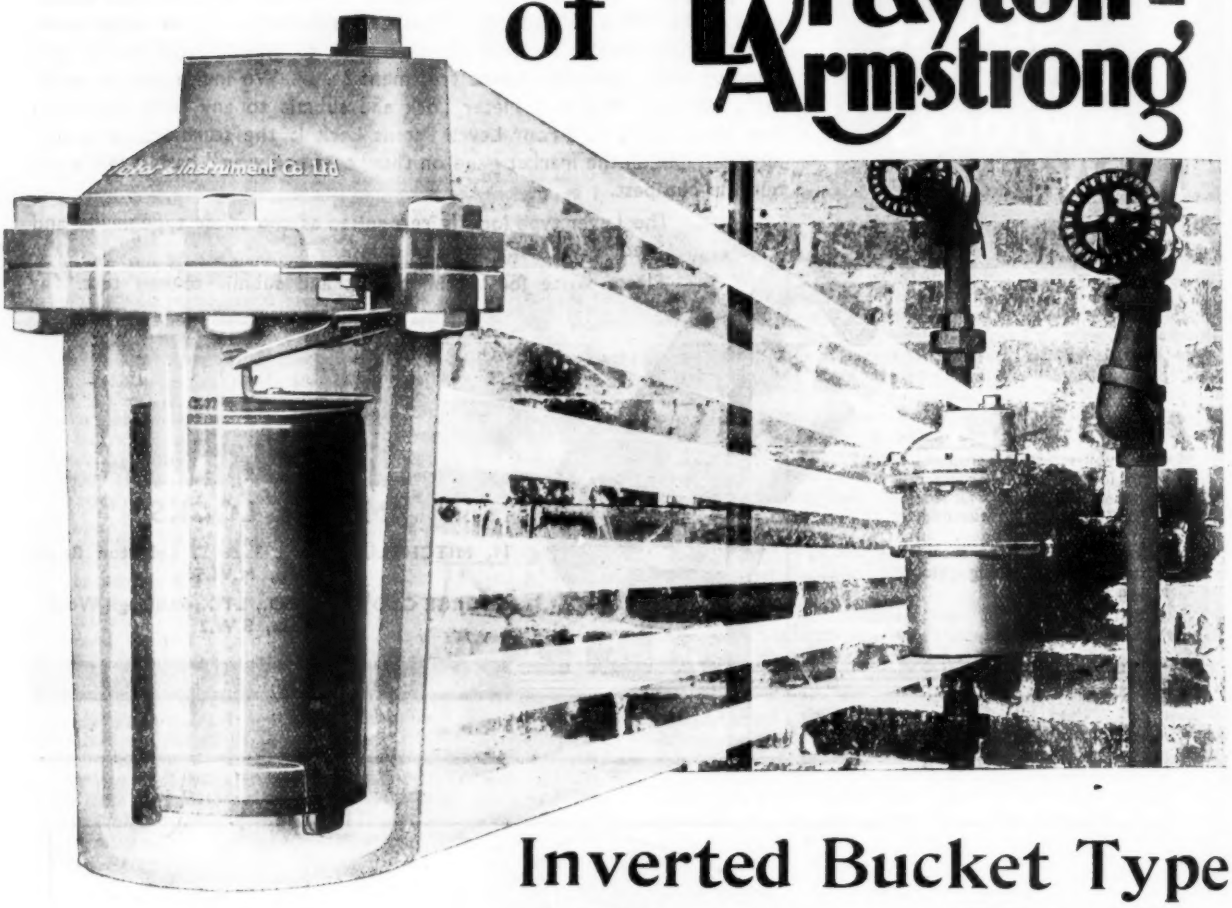

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500° or 600° C, and I am speaking of such jobs as oil heating, air drying and conditioning for process work, the melting of non-ferrous metals such as lead, &c., the melting of bitumastic compounds and so on. There are many fields in which with an increase of efficiency of heat transference as between a liquid or semi-solid and a solid and a gas, it is possible for gas, although much dearer in heat unit cost, to displace solid fuels on an economic basis. Considerable work has been done by Dr. Margaret Fishenden and others, but in almost all this work the problem of speed of travel of the gases in relation to the temperatures of the liquids to be heated arose. There is room for an enormous amount of investigation on heat transference at low temperatures and I feel it is on this line of investigation that we as an Institution should direct our attention.

Mr. JACQUES ABADY, K.C.: I mentioned this morning that I desired to contribute to this part of the discussion and the particular matter the importance of which I wish to stress is pushing on with research into the more efficient utilization of gas. I was going to hitch my wagon, not to a star, but to the question of sulphur in gas, and while I was going to do that the purport of what I was going to say dealt more particularly with the economic aspect of the new vista that is opening to the Gas Industry if they are in a position to grasp it owing to the orientation that is taking place in the type of industrial dwelling that will have to be erected in very large numbers both to deal with the more energetic Government policy under the Housing Acts and also the statutory duty which is imposed on local authorities under the Act of 1935, which makes it an offence to have more than a certain number of people in a house. That is what I was going to deal with, and I was going to try and make some practical suggestions to you not so much of a research character as dealing with the economic end of the problem.

The PRESIDENT: We shall be very glad to have your observations as to economic investigations.

Effect of Sulphur on Utilization.

Mr. ABADY: The point I want to emphasize is this. I observe you have been carrying on research with respect to purifying gas from sulphur and I take it, although I have not read the reports, that the lines which you have been investigating are the alternate ones which I think would present themselves to anybody—viz., either purifying the gas from sulphur or providing materials to be used in vehicles of combustion of gas which would be indifferent to the presence of the small amount of sulphur which is, in the absence of purification, part of the composition of town gas. I take it these are the two alternate lines of investigation. It seems to me that the presence of sulphur as we ordinarily know it is of no importance, or, in other words, it is no detriment to the consumer except where you have flueless combustion or where you require to condense the products of combustion. Flueless burning of gas is strictly limited and I think that the increase in consumption of gas which is being encountered on the part of small domestic consumers is a tribute to the satisfaction with present methods of gas making and distribution for cooking and heating. When we come to water heating, however, it seems to me that the inability or undesirability of condensing the products of combustion means that gas is not being utilized at anything like the full percentage of efficiency that is possible for the purpose of heating water, but if you take the case of the numberless flats which I have encountered in my own personal experience—otherwise I should not have ventured to have addressed you—the vital and central problem which confronts local authorities and those who provide flats is primarily how are you going to provide these people with hot water cheaply. You have to recollect that the kind of rent that can be paid by the people who have to be catered for, not singly but in thousands, in the next decennium is a rent with rates not exceeding 9s. or 9s. 6d. a week and in some places very much less, and it seems to me that the Gas Industry should in its economic research try and lead to the result whereby the necessary heat services including cooking and water heating can be provided for a weekly sum which bears a reasonable proportion to that rent. If I am right that the necessity for hot water in the interests of the decency of the lives of the people whom we want to lift up and put into better conditions is an important thing, then surely instead of using gas in which you are only utilizing 65 per cent. of the heat available the endeavour should be made either to purify the gas from sulphur or see that the vehicles of combustion are made from materials which would take no notice of the sulphur and so make use of very nearly 100 per cent. of the heat. The point I want to make is that it is a vital necessity that in researching as to the more economic use of gas you have to look at the thing to a large extent from the point of view of the dwellers in the small houses and flats that are going to be erected, and however you accomplish it or whatever steps you may take I think you have got to try and work up to a weekly budget which renders it necessary that whether there is smokeless fuel or gas, the cost of fuel is only a small proportion of the rent. If I may say so I think the Gas Industry has taken very great strides in that direction, but except in the larger towns where great energy is being displayed I cannot help feeling that the Industry has fallen very far short of that good and efficient standard with which it ought to be satisfied.

Economics and Efficiency.

The PRESIDENT: I am sure we appreciate Mr. Abady's suggestion and we appreciate the desirability of being able to sell gas on a weekly basis. Mr. Abady, of course, has been for some time out of direct connection with the practical side of our Industry, otherwise he would appreciate that we have to-day water heaters which do take out the heat of the products to the point of condensation of those products, heaters which are working at a very high efficiency indeed. The only trouble that we have is that unfortunately the first cost of such heaters is of necessity fairly high by reason of the construction which is necessary to secure that efficiency, and we hope that with development and increased production that cost will be reduced. At the same time when we come down to the real economics, the speculative builder who is not directly concerned with the ultimate efficiency of the heating operations of the heating installations in the houses which he is building, is inclined to put in that which is cheapest in first cost and not to choose that which will be most economic in continuous operation, and that is the greatest difficulty which we as an Industry have to contend with. The back boiler and a cylinder can be put in for half the price of the gas water heater and therefore the back boiler and cylinder goes in whether we like it or not and even the person who is eventually going to buy or occupy the house has no say, in the majority of cases, in its original equipment. We hope that the Government which is so anxious, and rightly anxious, to assist the coal miner will, in due course, have regard to the fact that if the highest price is to be obtained eventually for our coal then efficiency in utilization in the home must be secured, but it is very hard to see how even the Government can overcome the fact that the speculative builder is going to make the last pound he can on the cost of his houses and is going to set up for himself in the majority of cases a cheap rent in perpetuity.

I am afraid that perhaps I have been guilty of going a little outside the real purpose of this discussion, but I was so interested in what Mr. Abady said and I am sure that from my somewhat attenuated reply he will appreciate some of the difficulties that we have to face. Even having secured efficiency in our apparatus there are many other obstacles that we have to overcome before we can secure their utilization by the public.

Mr. ABADY: If I may say so, that is why I stressed the economic side. I am well aware of the efficiencies that can be obtained, but I thought that the focal point was the cost per week.

The PRESIDENT: Not the cost per week but the first cost.

Mr. ABADY: Precisely. That is part of the economics.

Technical Workers and Institution Membership.

Following the discussion on the Report of the Joint Refractory Materials Committee on Nov. 5, the PRESIDENT said:

You will all remember that at the last Autumn Research Meeting and again at the June Meeting of the Institution there was raised the question of admitting as members of the Institution all technical workers in the Industry who are occupying positions of responsibility and who have attained the necessary eminence to admit them as members of the Institution. It is a very difficult matter to define where the technical gas engineer leaves off and where the fuel technician begins. I use the word fuel technician in contradistinction to a chemist and I might perhaps introduce the chemist as being directly allied to the concern and as representing in person sometimes both the gas engineer and the fuel technician. There is no doubt about it, however, that we are all pure technicians; we are obliged to be if we are going to conduct our business as gas engineers and we must have the necessary chemical knowledge to equip us as fuel technicians. I do not need to belabour the point, because I think we all appreciate it, but there are many technical workers to-day who are contributing to the work of the Institution and would be most desirable members, but owing to the exact wording of our present Constitution they are not eligible for membership.

Your Council have been applying themselves to the consideration of minor revisions which would allow not only

technical workers in gas works but also other members of the carbonizing industry, who are directly concerned in carbonizing engineering, to become members. For example, we have the coke ovens which are to-day supplying in many areas a considerable quantity of gas to the gas works and the aim is to allow these men to become members of the Institution. Of course, there is also a third factor. Under the present Constitution a candidate for admission to membership as an associate member of the Institution if he is a Graduate he must be a Graduate of Leeds University. He may have taken a Degree in Fuel Technology in another University and he may have gone through the practical course at a gas works following on having taken that degree, but if it is not a degree in what is termed gas engineering, he cannot be admitted to associate membership. He can, however, be admitted to membership if he has been for 15 years in a responsible technical position in the Industry. Your Council consider that the standard of the Institution should not be lowered in any way and they are very desirous of maintaining the status and the position of the gas engineer, but they feel generally—I should not say your Council but the Executive Committee of the Council, because it is still under discussion by the Council in the form of recommendations from the Executive Committee—that we should make an attempt to include in our membership those technical workers who are qualified in fuel technology perhaps by a University Degree backed up by gas works experience and practical control. It is felt that some attempt should be made to alter the Constitution to admit such people as members. It seems entirely wrong, as Mr. Lacey indicated in his speech at the Luncheon to-day, that there are quite a number of our research workers who unfortunately are not eligible for membership of the Institution. How it is going to be brought about has not yet been definitely decided, because the recommendations that have been put forward are under consideration by the Council. We hope that the other Chartered Institutions—*i.e.*, the Institution of Civil Engineers in the main, will not take exception to our desire to include as gas engineers those fuel technologists who are directly concerned in the work of the Industry. If the Institution of Civil Engineers are not opposed to our suggestions and proposals, and if these suggestions and proposals are approved by the Council and by you as a whole, then we may succeed.

I have taken this opportunity of mentioning this point in order that you might appreciate that it is having the careful consideration of your Council, but, of course, I have to assure all the Corporate Members of the Institution that nothing will be done by your Council until the whole of the recommendations have been considered and approved by you in general meeting. I felt, however, you would like to know on this occasion that the matter is receiving attention.

The Institution Research Luncheon

On Nov. 5, the President (Colonel W. MONCRIEFF CARR) and the Council entertained at a luncheon at the Savoy Hotel those associated with the Research and Education work of the Institution. Among the distinguished guests not directly connected with the Gas Industry were Mr. J. M. Kennedy, O.B.E., President, The Institution of Electrical Engineers; and Colonel A. E. Davidson, D.S.O., President, The Institution of Mechanical Engineers.

The Loyal Toast having been honoured,

The PRESIDENT proposed "The Guests," who, he said, were those mostly concerned in the research and investigation work appertaining to the Industry. The Institution was privileged, however, to have among its guests the representatives of two of the leading Chartered Institutions, as well as others interested in the development of the Gas Industry.

It appeared from the happenings of the last year, the President continued, that very shortly, in fact almost at once, many of the investigations would have to be turned into a wider field. There would have to be much closer co-operation between the Institution's fuel investigation and that of both the Coking Association and the Institute of Fuel. They were watching with the greatest interest the experiments that were being carried out in the production of oil from carbon monoxide and hydrogen. The possibilities of these experiments, so far as they affected the Gas Industry, and indeed the nation as a whole, were really too vast for contemplation. The public of to-day required portable fuel and cleaner fuel, and he believed that at no far distant date coal in its raw state would not be utilized by anyone. Some of it would be used perhaps in pulverized form, much of it in gaseous form, and much of it in liquid form. If the liquid fuel were to be produced by way of the original carbonization of the coal, the production of carbon monoxide from the coke and the addition of the hydrogen, its potentialities as affecting the Gas Industry were indeed very great. He visualized that the gas would be distributed throughout the country for industrial and domestic purposes and the oil produced from the solid carbon residue would be distributed for use in internal combustion engines. It was amazing to contemplate the advance that had been made in investigations and experiments in this direction in Germany, and, he believed, in some degree at H.M. Fuel Research Station.

Speaking of matters which directly affected the Industry in the conduct of its daily work, the President emphasized that research and investigation were of vital importance; and scientific research must always be associated with economic research. While the Industry was watching carefully, and with great success, the results of investigation on fuels, and making the best use possible of the coal and the best selection of coals to produce coke which could be used in the best way domestically, they were not a little concerned also with the economic position in so far as it was affected by the political situation and the situation as affecting the basic industry of coal mining. He believed that as a whole the Gas Industry were desirous that the miners should be in receipt of higher wages; they were prepared to pay more for their coal, provided that every other user of coal throughout the country paid more in the same ratio, and they hoped that that very desirable achievement would be brought about in due course by His Majesty's Government. But it must be brought about without discrimination; there must be no discrimination against the public utilities, all users of coal must be on the same footing. Any other step must be a retrograde step from the point of view of the interests of the nation and, in his opinion, could not succeed.

In this connection he might well refer to one organization within the ranks of the Gas Industry—the London Coke Association—which was endeavouring to maintain satisfactory coke supplies throughout an area, to co-ordinate supplies, and to regulate prices so that neither the Gas Industry nor the consumer was exploited by any third party. It appeared desirable that such associations should be established throughout the country, that the Gas Industry, in co-operation with the coking industry, should set up associations to protect the position as had been done in the London area. This would become increasingly necessary because, if the Gas Industry was to pay more for coal it must have an equivalent increase in the price of coke. It behoved all concerned to take a very broad view and to endeavour to find ways and means of working in conjunction with the coking industry in this matter. Such associations, in addition, would be extraordinarily

helpful in representing the fuel position as affecting the Gas Industry to the investigation committees that would be set up in all areas to ensure that nobody was unfairly prejudiced by the execution of the provisions of the Coal Mines Act.

In another direction he hoped it would be possible to find machinery not only that would bring the research work of the Gas Industry into closer liaison with that carried out, perhaps in a very much smaller degree, by the coking industry, but also to strengthen the liaison between the Gas Industry and H.M. Fuel Research Station. Though wonderful progress had been made, there remained much to be done by co-operation with other bodies working on the same lines as the Gas Industry.

In extending a welcome to Mr. J. M. Kennedy, President of the Institution of Electrical Engineers, Colonel Carr said that electricity could be made to give heat, and, of course, it afforded excellent power and excellent lighting. But it was not in fact a fuel in the accepted sense. Therefore, provided the Gas Industry developed its business on the lines it should follow, and provided that it put such charges into operation as were economically proper in accordance with the demands made upon it, electricity could never take from gas its function as a fuel. The Gas Industry would continue to expand in the supply of an easily controlled fuel to industrial and domestic users; the electrical industry would continue to undoubtedly expand in the supply of power. In some applications of heat, as, for example, in certain cases of welding, electricity could do better than gas, depending, of course, upon the cost, but there was an enormous field for the expansion of gas. Eventually we should see the electrification of our railways, and smoke would be abolished entirely from our factories and houses. The two industries were working towards the same objectives, although he believed the Gas Industry would be first so far as fuel was concerned, and the electrical industry would be first so far as power was concerned, for direct application and for convenience of utilization.

The President, in conclusion, extended a special word of welcome to Colonel A. E. Davidson, the President of the Institution of Mechanical Engineers; and coupled with the toast the name of Mr. Kennedy.

Mr. J. M. KENNEDY, O.B.E., M.Inst.C.E., M.I.E.E. (President, Institution of Electrical Engineers), responding, said he appreciated, of course, that the electrical and gas industries were apt to clash, and the clashes might produce sparks, maybe explosions—and sometimes even sulphurous fumes But they could take it in good part, because, after all, as Colonel Carr had so aptly remarked, they shared a common aim—to remove the appalling pall of smoke and grime surrounding our industrial cities. There was an enormous field for the efforts of both of them there, and it required the application of their best endeavours and brains to eliminate that condition of affairs, which modern civilization should not have tolerated so long. In getting rid of smoke, whether by the aid of gas or electricity, they would remove also a great deal of the drudgery of the working-class household—and that in itself was an aim well worthy of achievement.

There were other directions in which their objects were common. As research workers, administrators, or salesmen, it would be greatly to their advantage if they could from time to time share their experiences. Again, from the point of view of legislative interference, they were on common ground—although he had heard some of his gas friends say that the electrical industry was being subsidized by the Government. He could agree with that if there were a negative sign and not a positive sign in front of the word "subsidy." It must almost bring tears to the eyes to know that the poor little electrical unit had to provide a subsidy to the Government in the shape of rates and taxes to the extent of 6d. per therm. How would the Gas Industry like to pay 6d. per therm in rates and taxes? He felt sure they did not fear electrical competition in these circumstances.

At a function in Switzerland last year reference had been made to the carbonization of coal by means of electrical energy. For years there had been a power station alongside the gas works at Beckton, and he remembered once producing figures which indicated that where there was a big power station, such as that at Barking, in the vicinity it would pay to use electricity for carbonization instead of wasting producer gas. If the worst came to the worst, the electrical industry could use gas to produce electricity, and electricity could be used to produce gas, and they could live by taking in each other's washing.

But the great problem was the proper utilization of coal, as Colonel Carr had so justly remarked. As they achieved the abolition of the use of raw coal in industrial furnaces or domestic grates, the greater would their problems become, because it was obvious that as the coalowners increasingly lost the household coal market there would be a tendency for the price of the raw material to be adjusted, and that adjustment would be upwards. But they had to face that, and yet they had to maintain progress. They could maintain progress only by reducing prices, and if they had to reduce prices in spite of the fact that the price of their raw material was increasing they must have the very best brains devoted to research. They would both benefit greatly by the help they received from the Fuel Research Station at Greenwich, and the Coal Survey. The healthy rivalry that existed between the gas and electricity was a stimulus to progress, and neither would derive any harm from it.

(Owing to indisposition, Professor Jocelyn F. Thorpe, C.B.E., D.Sc., F.R.S., President of the Institute of Chemistry, who had consented to propose the **Toast of "The Institution of Gas Engineers,"** was unable to attend.)

Colonel A. E. DAVIDSON, D.S.O. (President, Institution of Mechanical Engineers), proposed the toast of the Institution. When, he said, he had occupied Government quarters he had always been very glad to have a gas supply; and he would be very sorry not to have both gas and electricity available in his house. The competition between gas and electricity was of benefit to individual consumers; and the two industries had both scored from the extraordinary increase in the standard of house warming and house lighting in the last generation.

As representing the Institution of Mechanical Engineers he could wish the Gas Industry the very best of luck; for, while there was much chemical engineering in the Gas Industry, there was also a vast amount of mechanical engineering. The Institution of Mechanical Engineers had received one or two most interesting Papers from members of the Gas Industry, and would be glad to receive more from time to time. One could not help noticing the amount of publicity and advertising on behalf of the Gas Industry, which had a very well laid out form of propaganda. As a private householder, Colonel Davidson offered the suggestion that if gas appliances were fitted with a device which would limit their consumption to a definite maximum per hour, just as electrical apparatus was rated at a certain number of watts or kilowatts, it would be very much appreciated. An electrical appliance, he said, could not burn more than the rated amount of current. [Laughter.] A customer who knew exactly what his apparatus would consume would appreciate it and would be more willing to take the apparatus into use.

Mr. STEPHEN LACEY, B.Sc. (Vice-President), responding, commented that it was very sporting of Colonel Davidson to have consented to propose the toast at short notice, in the regrettable absence of Professor Thorpe. The occasion, he continued, was a thanksgiving luncheon to the many individuals, whether members of the Institution or not, who had assisted in the research, investigation, and educational work directed by the Institution. The spirit of the research workers was one of the most far-reaching influences imaginable, and fortunately in the world of research there were fewer barriers to the interchange of ideas and to sensible co-operation than was the case in the world at large. That was why he welcomed on that occasion not only those engaged in the Institution's research work, but also distinguished gentlemen representing similar institutions. It had been for him a pleasing experience to sit between the Presidents of the Institution of Electrical Engineers and the Coke-Oven Managers' Association and to discuss their common problems.

Inasmuch as he had expected to reply to a speech by Professor Thorpe, it had been his intention to speak of chemists. As showing how great a part was played by qualified chemists and physicists in the research work of the Institution, he said that, for example, three of the nine members of the Research Executive Committee, the directing and co-ordinating Committee of the revised research organization, were members of the Institute of Chemistry, of which Professor Thorpe was President. It was obvious that the Institution would rely more and more on the work of physicists and chemists, and one regretted that those who served on the technical sub-committees and who contributed Papers and opened discussions were not all eligible for membership of the Institution.

Sir DAVID MILNE-WATSON, D.L., LL.D., M.A. (President, National Gas Council), proposed a toast to the President, Colonel Carr, and wished him the best of luck during his year of office.

Day by day one realized more and more the importance of research, and it was even more important in the old industries than in the new. The new industries acted as lodestones to the young men; the older industries must look to themselves and see to it that they were provided with good researchers to carry on their work. No industry could carry on without research. Therefore, he heartily welcomed the Autumn Research Meetings of the Institution, which did an incalculable amount of good.

The PRESIDENT briefly responded.

News in Brief

The Ceramic Society are holding the Autumn Meetings of the Refractory Materials and Building Materials Sections in London from Nov. 19 to 21.

Additional Lighting is to be installed at Newcastle-on Tyne, where a £12,865 scheme for the erection of gas and electric lamps in the streets is to be undertaken by the City Council.

Mr. J. Hood, A.M.I.Mech.E., Engineer and Manager of the Birkenhead Gas Department, recently addressed the members of the Local Rotary Club on the subject of the Gas Industry.

The Issue of 100,000 4½% cumulative preference shares of £1 each at 21s. per share in the Caledonian Gas Corporation, Ltd., advertised in our columns last week, was quickly oversubscribed.

A Declaration of Calorific Value has been made by the Preston Gas Company to the effect that the gas supplied by the Company as and from Feb. 1, 1936, will be of 470 B.Th.U. per cu.ft.

An Increase of Authorized Capital is the object of a Special Order for which the Stone Gas Light and Coke Company intend to apply to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934.

Applications are Invited by the Sowerby Urban District Council for the position of Gas Engineer and Manager. The commencing salary offered is £450 per annum, rising by four annual increments of £25 to a maximum of £550 per annum.

Application for a Special Order under the Gas Undertakings Acts, 1920 to 1934, is intended to be made to the Board of Trade by the Wellingborough Gas Light Company. The objects include an extension of the limits of supply of the Company and the declaration of the calorific value.

Under the Auspices of the Wigan Corporation Gas Department, an exhibition of modern gas appliances was held in the Baths Assembly Hall, Wigan, from Oct. 28 to Nov. 1, a feature being the practical cookery demonstrations given each afternoon and evening by Mrs. E. Hardy, of the Radiation Research Kitchen, which were well attended.

The Fiftieth Anniversary of the first patent in connection with incandescent gas mantles taken out by Dr. Carl Auer von Welsbach was recently celebrated in Berlin at a joint meeting of the German Gas and Water Engineers' Association and the German Association of Chemists, when Dr. Ing. Karl Quasebart gave an address on the life and work of Welsbach.

Gas Cookery Demonstrations in various districts served by the Farnham Gas and Electricity Company were held from Oct. 7 to 25 inclusive. The Demonstrator was Miss G. L. Hughes, of The Parkinson Stove Company, Ltd., and a comprehensive range of Parkinson cookers and fires was on view. The exhibition was very well attended, and a large number of appliances were sold.

The Gas Industry Had a Good Advertisement on the Haymills Hanger Hill Estate, Middlesex, on the evening of Oct. 30, when the electric supply failed for an hour and a half. There is one house on the estate wholly lit by gas, and, while the rest of the occupants were struggling in the dim light of guttering candles, the occupier of this house turned on all his lights and drew back all his curtains. No good deed in a naughty world ever shone more brightly than that night at 25, Audley Road.

A Dividend of 4% Per Annum, less tax, in respect of the half-year ended Nov. 30, 1935, on the 4% redeemable cumulative preference shares is announced by the Directors of Gas Consolidation, Ltd. The dividend will be paid on Dec. 2, 1935, to all shareholders whose names appear on the Company's register on Nov. 25, 1935. An interim dividend of 2% actual, less tax, on the ordinary shares is also announced in respect of the year ended May 31, 1936, and is payable on Dec. 2, 1935, to all shareholders of record Nov. 25, 1935.

The Institution of Gas Engineers

Members of The Institution of Gas Engineers are invited to attend the Meeting of the Institution of Engineers-in-Charge at the St. Bride Institute, Bride Lane, Fleet Street, E.C. 4, on Wednesday, Dec. 11, 1935, at 7.30 p.m., at which three short Papers on "Central Heating and Hot Water Supply" by Gas, Electricity, Coal, and Coke will be read by R. J. Willsmer, A. Klausner, and H. F. Philliston, respectively.

Light refreshments will be served from 6.30 to 7.15 p.m.

Admittance tickets may be obtained from the Secretary, The Institution of Gas Engineers, 28, Grosvenor Gardens, S.W. 1.

Amalgamation and Grouping

United Kingdom Gas Corporation, Ltd.

Close Brothers, Ltd., the Secretaries of the United Kingdom Gas Corporation, Ltd., announced on Nov. 7 that the Corporation has acquired 90·6% of the "A" shares and 98% of the "B" shares of the Ackworth, Featherstone, Purston, and Sharlston Gas Company, 96% of the 10% "A" ordinary shares, and 95·9% of the 7% "B" ordinary shares of the Frodsham Gas and Water Company, 94·8% of the 10% (old) ordinary shares and 85·5% of the 7% (new) ordinary shares of the Runcorn Gas Company, and 97·8% of the original stock and 97% of the additional "B" stock of the Drighlington and Gildersome Gas Light Company.

The United Kingdom Gas Corporation's offer to the holders of the consolidated ordinary shares of the Prescot and District Gas Company to purchase their shares has been accepted to the extent of 95·71%.

Daily Express "Help Your Neighbour" Campaign

Gas Section of Window Display Competition

As already announced the gas displays entered for the *Daily Express* Window Display Competition will also be judged for the special prizes offered by the British Commercial Gas Association. First Prize—£25 cash and the B.C.G.A. solid silver Challenge Cup to be held for one year. Second Prize—£15 cash. Third Prize—£10 cash. Ten consolation prizes of £5 each will also be awarded.

The judges will be: Sir Frederick Marquis, J.P., Joint Managing Director, Lewis's, Ltd., Sir Francis Goodenough, C.B.E., and Mr. Richard Harman, Editor of *Display*.

The results will be announced shortly after the judging of the main competition.

South Metropolitan Gas Company

Adoption of a 4,000 B.Th.U. Gas Unit

For the convenience of consumers and to facilitate comparison with the cost of other forms of fuel and energy, the Company has introduced a gas unit of 4,000 B.Th.U. An explanation of the new unit is being circulated to consumers in a leaflet of which an extract appears below:

Has it occurred to you how large a part comparison plays in determining your purchases? Unconsciously, perhaps, you compare one article with another for price, quality, or convenience, and then on the result of your comparison arrive at your choice.

Now it is difficult to make comparisons unless the same unit of measurement applies to all articles of the same class. For instance, a housewife knows that she can buy her butter, tea, or coffee by the pound whether she goes to Mr. Smith's shop or Mr. Brown's. She has thus an easy means of comparing the wares of the two grocers, but she would not have such a means if one charged by the pound and the other by the stone. Similarly, a motorist may wish to find out what mileage he can get from petrol and what from benzole. The gauge on his tank is in gallons, and the spirit he buys from the pumps is sold to him in gallons whether it is benzole or petrol. If he had to buy one by the gill and the other by the gallon he would be involved in mathematical calculations which are as unnecessary as they might be confusing.

Exactly the same principle holds good for another frequently used commodity—heat; and the South Metropolitan Gas Company, recognizing this fact, proposes to provide a similarly easy basis of comparison by introducing a new unit, a "Gas Unit," the explanation of which is as follows:

The efficiency of gas depends on its ability to generate heat. The boiling of water in a kettle, the roasting of a joint in the oven, the warming of a room with a gas fire,

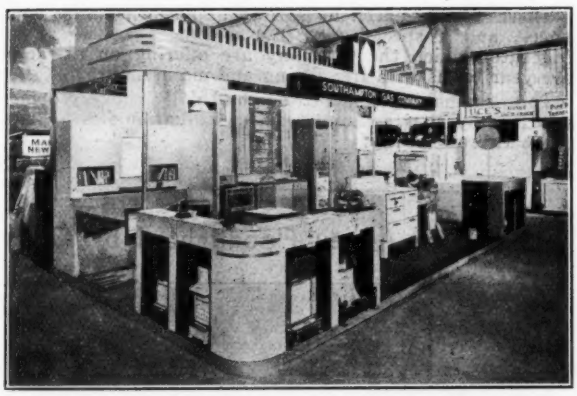
and the light of an incandescent mantle all depend on heat; and therefore the fairest method of charging for gas is by the amount of heat supplied and not merely by the number of cubic feet, the heating value of which might vary to a greater or less degree. This is why Parliament, at a request which came spontaneously from the Gas Industry and was put forward entirely in the interests of consumers, has required gas to be charged for on a heat basis.

The adopted basis is one of 100,000 B.Th.U., and a British thermal unit is the amount of heat required to raise the temperature of a pound of water 1° F. This unit is an exact and fixed scientific quantity and has, therefore, been taken as a standard of measure for other processes and kinds of energy which, like gas, function through heat. But for different forms of supplying heat different multiples may, of course, be taken as a basis of charge; for instance, electricity is charged for by what is known as a Board of Trade unit, which, although based upon a measure of physical reaction, is equivalent to 3,412 B.Th.U.

Obviously, it is not easy to compare an electrical unit of 3,412 B.Th.U. with a gas therm of 100,000 B.Th.U.; the latter is too large a quantity. It is, however, most desirable to know exactly what each method costs; and for this an easy basis of comparison is essential. To provide such a means of comparison the South Metropolitan Gas Company has decided to introduce a sub-division of the therm, to be called a "Gas Unit." This "Gas Unit" will be one twenty-fifth of a therm, and will thus be equal to 4,000 British Thermal Units. Its cost, with gas at 8¾d. a therm, will be a twenty-fifth of that sum, or only just a little more than a third of a penny.

In future, therefore, while the total charge will be shown in therms, each gas account will also show the number of "Gas Units" used since the last reading of the meter. It will be observed that no change is made in the price of gas or in the method of charge. Gas accounts will not be affected in any way, except that they will now provide what, it is hoped, will be an additional and informative guide to the value of the services for which the consumer is asked to pay.

A Gas Exhibit at Southampton



Our photograph shows the attractive display of the Southampton Gaslight and Coke Company at the recent "Queen Mary" Exhibition held at the Coliseum, Southampton.

Oriental Gas Company, Ltd.

Increased Gas Sales Recorded

The Annual Report and Statement of Accounts of the Directors of the Oriental Gas Company, Ltd., for the financial year ended June 30, 1935, to be presented to the proprietors at the Ordinary General Meeting of the Company to be held on Nov. 21, shows that there has been an increase in the sale of gas of just over 1½%, together with an addition to the number of gas appliances sold or installed during the year of 708.

The Revenue Account shows a profit for the year of £26,235, which sum, added to the profit on exchange, bank interest, &c., and the balance of £94,527 brought forward from the previous year, amounts to £128,574. After providing for the payment of the interim dividend paid in May last and transferring £10,000 to the Reserve Fund, there remains a balance of £108,074, out of which the Directors recommend the payment of a final dividend of 4½%, free of income-tax, making 8%, free of income-tax, for the year—which will leave the sum of £94,574 to be carried forward to the current year.

Two Public Lighting Systems at Omagh

Electricity Refuses to Quit

A very odd situation has arisen recently in Omagh where, as was announced in the "JOURNAL" for July 28, gas is replacing electricity as the medium for public lighting.

For several nights the town has been illuminated by both agencies. The Urban Council, who have expended £5,000 on improvement to the gas services and lamps, served notice on the Electricity Board for Northern Ireland to terminate their contract for street lighting on Oct. 31 as the new gas lighting would be then complete.

The Electricity Board, however, held that they are entitled to light the streets to the end of the present session as the Urban Council's notice was insufficient, and on Friday night, Nov. 1, the streets were a blaze of light with both gas and electricity. It is stated that the Electricity Board base their rights to carry out the street lighting on legal grounds, and the whole question was discussed at a meeting of the Finance Committee of the Urban Council, when it was decided to refer the matter to their solicitors for advice.

Forthcoming Engagements

Nov.

14.—SOUTHERN ASSOCIATION (EASTERN DISTRICT).—Meeting at 28, Grosvenor Gardens, S.W. 1.

15.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Annual Dinner.

16.—WESTERN JUNIOR ASSOCIATION.—Meeting at Exeter. Paper by Dr. C. M. Cawley, of the Fuel Research Department.

16.—YORKSHIRE JUNIOR ASSOCIATION.—Meeting at Shipley. Presidential Address of Mr. J. W. Carlton.

19.—I.G.E.—Session at the 8th Public Works, Roads and Transport Congress and Exhibition, Royal Agricultural Hall, London, N. 1, 3 p.m.

20.—B.C.G.A.—Executive Committee at 11.30 a.m.

20.—MANCHESTER DISTRICT ASSOCIATION.—Joint Meeting with the Institute of Fuel (North-Western Section) at Manchester.

21.—MIDLAND ASSOCIATION.—Autumn General Meeting, Imperial Hotel, Birmingham.

29.—I.G.E.—Liquor Effluents and Ammonia Committee, 11.15 a.m.; Joint Research Committee, 2.30 p.m.

29.—SOUTHERN ASSOCIATION.—General Meeting at the Hotel Metropole at 2.30 p.m.

29.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Meeting. Paper by Mr. W. Grogono, of Croydon.

30.—NORTH OF ENGLAND G.M.A. (AUXILIARY SECTION).—Meeting at Newcastle-on-Tyne and Paper by Mr. D. Yule.

Dec.

3.—I.G.E.—Research Executive Committee, 2.30 p.m.

4.—MANCHESTER AND DISTRICT JUNIOR ASSOCIATION.—Visit to Birkenhead. Paper by Mr. A. J. Walker.

5.—MIDLAND JUNIOR ASSOCIATION.—Annual Dinner.

7.—SCOTTISH EASTERN JUNIOR ASSOCIATION.—Meeting at Arbroath.

11.—B.G.F.—1st Annual General Meeting, Grosvenor House, Park Lane, London, W. 1, 3 p.m.: 2nd Annual Dinner, Grosvenor House, Park Lane, London, W. 1, 7 p.m.

11.—I.G.E.—Finance Committee, 9.30 a.m.; Membership Committee, 9.30 a.m.; General Purposes Committee, 9.30 a.m.; and Council, 11 a.m.

13.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Paper by Mr. L. Friedman, of Ascot Gas Water Heaters, Ltd.

14.—SCOTTISH WESTERN JUNIOR ASSOCIATION.—Meeting and Address by Mr. W. D. Rowe, of the B.C.G.A.

14.—WALES AND MONMOUTHSHIRE JUNIOR ASSOCIATION.—Meeting at Cardiff. Paper by Mr. B. J. Bell.

14.—WESTERN JUNIOR ASSOCIATION.—Meeting at Torquay. Paper by Mr. J. W. Denton, of Torquay.

21.—SCOTTISH WESTERN JUNIOR ASSOCIATION.—Annual Social.

Colonial Gas Association

New Share Issue

In conformity with the announcement by the Chairman at the Annual General Meeting of the Colonial Gas Association, Ltd., held in Melbourne on Oct. 2, the Board has decided to make an issue of shares, available in the first instance for application by shareholders. The issue will be of 115,066 ordinary shares of £1 each, at par in sterling, to rank *pari passu* with the existing ordinary shares. Special forms for shareholders' "rights" are being issued according to the Register on Nov. 11, and applications must reach the Company's London office, 15, Victoria Street, S.W. 1, by 5 p.m. on Nov. 25.

An Attractive Standard Lamp

This pleasing standard gas lamp is a recent production of Messrs. Falk, Stadelmann, & Co., Ltd., which strikes a very modern note. The lower portion of the standard is obtainable in finishes of blue, black, red, green, and antique ivory, the upper sections being chromium plated and incorporating the Veritas "Spherelite" burner.

The Action of Cold Water on Metallic Materials

A Berlin Congress on Corrosion

The leading German technical and scientific associations, who united to form a joint council in connection with corrosion and its prevention, are holding the Fifth Annual Congress in Berlin on Nov. 18-19 of this year.

At the previous meetings, corrosion was dealt with very broadly, a variety of Papers being presented, but this time it has been decided to confine the attention of the Congress to one particular theme: "The corrosion of metallic materials of construction by cold water."

Of Interest to Gas Engineers.

This subject is of vital importance in all branches of industry, but particularly is it of interest to gas and water engineers, and industries concerned with the disposal of effluents, more particularly from chemical works. A number of questions of technical and economic importance will be dealt with for the first time, the various speakers being experts on their particular subjects.

In addition to the Papers of more general interest, such as those dealing with the damage done by water corrosion and the methods employed for its prevention, it is proposed to present Papers dealing with rapid methods for the determination of rate of corrosion, and the standardization of the laboratory equipment and methods of expressing the results of corrosion tests.

A number of well-known specialists from abroad will take part in the discussion, among them being Prof. Palmaer, of Stockholm, Prof. W. J. Mueller, of Vienna, and Prof. Kohlschütter, of Berne.

The administration of the Congress has been entrusted to the Verein deutscher Chemiker, Berlin W 35, Potsdamer Str. 103a.

Gas Exhibition and Demonstrations at Dartmouth

Much Local Interest Created

The fourth annual exhibition arranged by the Dartmouth Gas, Coke, and Coal Company, Ltd., was opened in the presence of a large gathering at the Subscription Rooms, on Nov. 4, by the Mayor of Dartmouth, Councillor E. A. Travers.

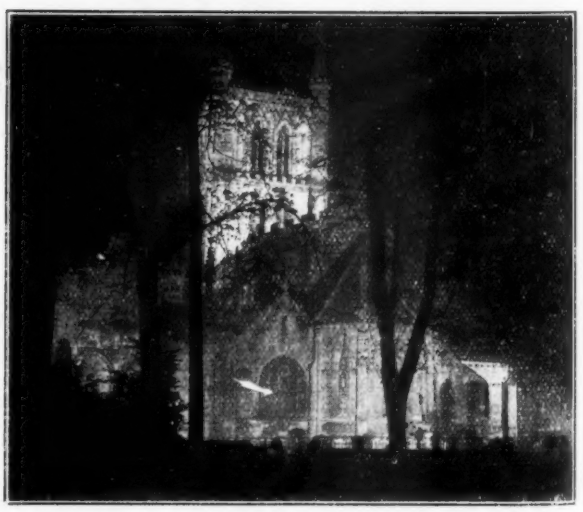
The Mayor paid high tribute to the Gas Industry and the efficient policy pursued by the Dartmouth Company. "The Gas Industry in this country has a great record behind it," he concluded. "It has, in my view, an equally great future in store. We have no oil wells in this country, no water power, but we have cheap abundant supplies of coal. Then let us use that coal to advantage by carbonizing it at the gas-works. In that way we shall benefit ourselves and the miner at one and the same time."

The Chairman, Mr. Harold Adams, said the exhibition had been prompted by the Company's desire to keep the public informed of the latest developments of the Gas Industry.

There was an excellent variety of gas-consuming appliances, and a special feature was the "Freezolux" refrigerator which the Company are offering on attractive five-year terms with free fitting and maintenance.

The cake-baking competitions and daily cookery demonstrations by Miss E. Sanderson, of Radiation Ltd., excited great interest locally.

Pershore Abbey Floodlighted by Gas



On the occasion of an Organ Recital on Oct. 24 by Mr. H. Goss Custard, Mus.Bac.Oxon., F.R.C.O., Organist of Liverpool Cathedral, Pershore Abbey, Worcestershire, was floodlighted by the Cheltenham and District Gas Company. The lighting was carried out by means of four 12-light strip lanterns by Foster & Pullen, and two 10-light strip lanterns by Parkinson, the gas being supplied from a distance of 19 miles away.

The Society of British Gas Industries

AUTUMN GENERAL MEETING & LUNCHEON

The Autumn General Meeting and Luncheon of the Society of British Gas Industries were held at the Hotel Metropole, London, on Thursday, Nov. 7, under the Chairmanship, in the unavoidable absence of the President (Sir John Cadman), of Mr. Charles Clare.

Mr. D. M. HENSHAW,
Chairman of the Council.

LUNCHEON.

The Loyal Toast and that of the Duke and Duchess of Gloucester having been duly honoured on the call of the Chairman (Mr. Charles Clare), apologies for absence were read by Mr. F. B. Richards (Woodall-Duckham Companies). These were from the following: Sir John Cadman (the President), Mr. P. F. Holmes, Mr. S. Cutler (who has recently had to undergo an operation in Zurich, and to whom Mr. Richards voiced the sympathy of the members and their best wishes for a speedy and complete recovery), Sir Robert Hadfield (who was indisposed), Mr. F. J. West (who was assisting in the General Election campaign in Manchester), and Mr. R. B. Hodgson. Regrets were also expressed at the unavoidable absence, through illness, of Dr. E. W. Smith.

Mr. D. M. HENSHAW (Chairman of the Council) said that his part in the proceedings was a small one. It was to ask Mr. B. B. Waller to propose the Toast of their Senior Vice-President and very old friend and founder, Mr. Charles Clare. This was, said Mr. Henshaw, really a family party and also a birthday party. It marked the conclusion of thirty years' existence of the Society, and, in accordance with custom, there were no official guests, with the exception of the Technical Press, whom they regarded as privileged members of the Society. The Press were part of their family. It was, as he had said, a family of thirty years' standing, and they had a very lusty and vigorous "middle-aged parent." He hoped he was feeling in the prime of life and was glad to have his family around him. Most parents found that their families knew more about things than the fathers themselves. In that respect they were an exceptional family. Mr. Clare had seen the Society grow from a membership of 36 to 137, and he could have nothing but feelings of satisfaction in looking back over that long period of time, during which he had seen the Society grow in numbers and strength. Mr. Waller would propose this Toast in the absence of Mr. Fred West, who was the only member of the original Council left in addition to Mr. Clare himself.

A Memorable Occasion.

Mr. B. B. WALLER, in proposing the Toast to Mr. Clare, remarked that this was a very memorable occasion for the Society of British Gas Industries. As they had been told, it was their thirtieth birthday, and although they greatly regretted the absence of their President, Sir John Cadman, they all welcomed with very warm hearts their old friend Mr. Clare, who had been so good as to fill the gap and take the Presidential Chair on that occasion. Some of the messages which had already been read from absentees had rather covered the ground he was to have covered. But to the younger members of the Society, whose memories did not carry them back quite so far as his own, he would say that Mr. Clare was the founder of the Society, and for four consecutive years he worked actively for the progress of their organization. When Mr. Clare reflected upon those early years and then looked round the assembly that day he must be proud of his handiwork, and his efforts ever since those early days. They were all proud of their Society to-day; it had made very great advances. Looking back over the period of their existence and recording some of their earlier and more recent Annual Reports they would be able to appreciate the extensive amount of good work which this Society had done for the promotion and welfare of the Gas Industry. To-day he ventured to say that the S.B.G.I. was in the forefront of kindred organizations which were working for the advancement of the great Industry they represented. If it had not been for Mr. Clare there might have been no S.B.G.I., and they were pleased to have this opportunity of having him in the chair and of expressing to him their heartfelt thanks for all he had done for their Society in the past.

Mr. CHARLES CLARE, in acknowledging the Toast, which was heartily accorded with musical honours, first spoke with regret of the absence of their President, Sir John Cadman, for whom they had not, he was afraid, a very good substitute. He thanked the previous speakers very sincerely for the kind remarks they had made. He would like them to cast their minds back to those early days of the Earls Court Exhibition in 1904 and to the many difficulties with which they had to contend at that time, which did not tend to the welfare of those engaged in that work. During those proceedings there were several exhibitors who had come to him and had asked him whether the time was not ripe for the formation of an institution of some kind for manufacturers. He believed Mr. Thornton was one of those who approached him in that connection. But the difficulty was to get all the exhibitors in one mind—which he might say they did not succeed in doing; they got a good many of them, however. As a matter of self defence they considered that they should have a society of their own, and this suggestion he endeavoured to put into effect. Two gentlemen in particular assisted in this—namely, Mr. Bezant, late Editor of the "GAS JOURNAL," and Mr. Helps, of Croydon. These two did remarkably good work, taking off his own shoulders three-quarters of the burden of the work involved. Thus the Society came into being, and they then had to find a Secretary. He had been most happy to approach his old friend Mr. A. L. Griffith and ask him to take over these duties—which he did satisfactorily for so many years. The next point had been to find a President, and he had been introduced by Mr. Bezant to Sir Dugald Clerk, who, after a long conversation, agreed to set the ball rolling as the first President of the Society. This step had been of great advantage to them and led the way to a succession of Presidents whose names were household words. They had had a remarkable succession of Presidents, and no society had had better.

Early Apathy.

Many times during the first four years of the Society's existence, continued Mr. Clare, he had almost given up

hope, so much apathy was there. No one seemed to care anything about the Society; some said it would be an absolute failure, while others said it was not needed. But after a prolonged struggle they got the Society going, and although the Committee was then a small one, it worked very well—and they had seen what the results had been up to the present. There was nothing of particular interest about those early days; but some good did come out of the meetings, for they laid the foundations of the Society as it was to-day. As he had said, they had been very lucky in the appointment of their Presidents. It was essential that they should get the best men it was possible to obtain; and when they looked down the list of Presidents of this Society they would agree that it required much beating.

It had been a very great pleasure to him that the Society had progressed so well as it had. For the first four years he really did not think it would succeed at all. He was delighted to see the progress which had been made and which would continue to be made, especially as they were now one of the recognized groups of this great Industry.

In conclusion, Mr. Clare thanked them all most sincerely for their very warm welcome. He had hoped to see the twenty-fifth anniversary of their Society, and he was very gratified that he had now seen a good deal past that. He thanked them once again most sincerely for their kindness.

The Council.

Mr. C. DAVIS proposed the Toast of "The Council," remarking that the members had every confidence in that body. On it they had men who were held in high esteem in the Industry, men of considerable business experience and ability. The Society of British Gas Industries had reached a stage which it had never reached before, and they would like to take this opportunity of thanking the Council for the excellent work they had done on the members' behalf. It was to be hoped they would continue to bring the younger members on to the Council. This would give the young men a chance. They were very glad, he observed, to see Mr. Griffith with them on that occasion; he had done very good work for the Society. He would also congratulate the Council upon having appointed so excellent a successor in Mr. Burt. He was following in Mr. Griffith's footsteps very well, and in him they had a first-class business man to help them in their problems. He coupled with the Toast the name of Mr. Henshaw, Chairman of the Council.

Mr. D. M. HENSHAW, in acknowledging the Toast, voiced the satisfaction of the Council at the compliments which had been paid them. He could assure them that they did their best and worked together for the good of the Society and the Industry as a whole. The fact of their having officially joined the British Gas Federation put upon all of them certain responsibilities which they did not carry before. They would now, more than ever, be of use to the Gas Industry, and they must see that it was maintained as one of the major industries in the country.

The Golf Circle.

Continuing, Mr. Henshaw said he would like to take this opportunity of mentioning that Mr. Edgar, the Secretary of their Golf Circle, was unable to be with them that day, as a result of indisposition. He thought that they did not always give the Golf Circle the mead of praise which was due to this very live part of their activities. It was also a very important part. The Golf Circle was formed in 1911, and was re-formed after the war in 1919. It was a matter of interest to note that Mr. Davis, Mr. Thornton, and, he believed, Mr. Davidson were among the early pioneers of the Golf Circle. Mr. Edgar had an extraordinary capacity for organizing this important section of their activities and for getting an *entrée* into first-class clubs. Many of their friends on the supply side appreciated their invitations to join in the Society's two Annual Golf Meetings.

Mr. Henshaw went on to support the remarks which had been made in regard to Mr. Griffith and repeated how very pleased indeed they were to have him with them that day and see how well he was looking. At the same time he would pay tribute to Mr. Burt, his extraordinary value to the Society, and his very keen attention to the work, which had been of considerable assistance to the Council. They greatly appreciated his enthusiasm, and it was to be hoped that they would all do their very best to assist him in the work he was doing.

THE AUTUMN MEETING.

The Autumn General Meeting of the Society was subsequently held at the Hotel Metropole, and Mr. CHARLES CLARE again occupied the chair in the absence of the President, Sir John Cadman.

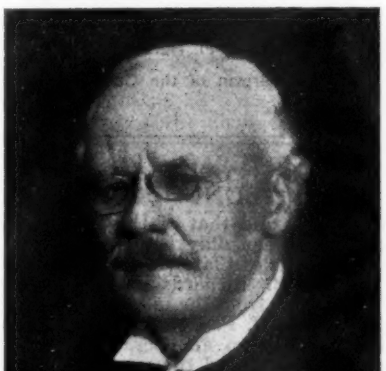
Mr. D. M. HENSHAW, before reading his Chairman's Address, said: To-day marks the completion of thirty years' existence of the Society of British Gas Industries, for although the decision to form such a Society was made early in 1905, officers were not appointed until 1906, when the Society was formally inaugurated under the Presidency of Sir Dugald Clerk.

In the unavoidable absence of the President this year, it is a great pleasure to have in his place Mr. Charles Clare, to whose initiative the Society owes its existence. Mr. Clare as our first Chairman was supported by a Council of ten.

It is a matter of regret that Mr. F. J. West, who succeeded Mr. Clare in the Chair in 1910 and has continued to be a staunch supporter of the Society throughout its history, is not able to be with us to-day. He has asked me to offer his apologies.

It is of interest to recall that with the exception of The Institution of Gas Engineers, which is, of course, a professional body, there was at that time no national body in existence to take care of the interests of any section of the Gas Industry. It is understandable perhaps that such an organization at first grew slowly. The membership in 1906 was 36; it is now 157.

We may recall with some pride that the Society was jointly responsible with The Institution of Gas Engineers for the formation of the British Commercial Gas Association in 1911, and since that time has been identified with countless activities which have contributed to the present strong position and the progressive policy characteristic of this great national Industry.



Mr. CHARLES CLARE,

One of the ounders of the Society, and who presided at the Autumn Meeting in the absence of the President, Sir John Cadman.

It is well known to you that the Council took an active part in the formation of the British Gas Federation, of which you are individually members by virtue of your membership of the Society of British Gas Industries. Similarly all members who subscribe to our special fund become members of the British Commercial Gas Association.

I feel I might very appropriately take this opportunity to speak shortly, as Chairman of the Society, on what the Council are striving to achieve in developing the general policy of the Society in the best interests of its members.

Through the Monthly Letter and in various other ways you have some impression of the numerous questions of detail that are engaging our attention, but I wish to refer briefly to matters of more general interest about which I feel all those who have the welfare of the Society at heart might be interested to hear.

First, with regard to our external activities. These have tended very much during the past year to find their focus in the British Gas Federation. We are endeavouring in every possible way through the Federation to pursue a policy of co-operation with our customers, the Gas Supply Companies and Undertakings.

Exhibitions.

We are represented, as you know, on the Council of the Federation and also on its Exhibitions Committee. Our Manager, moreover, is engaged with the officers of the other Member Organizations in securing closer co-operation in matters of detail, where prospects offer hope of this proving

of value to all concerned. The Exhibitions Committee of the Federation sponsored the excellent Industrial Gas Exhibit at the Shipping and Machinery Exhibition at Olympia in September, to which many of our members loaned apparatus; and it was at the pressing request of the Federation that we undertook to support the Gas Section at the forthcoming Birmingham Section of the British Industries Fair. It is gratifying to be able to state that a central space for this section has been secured, and although the area is larger than in previous years the whole of the stands have already been let.

We are also taking all reasonable steps to secure adequate representation of the Society at the many meetings and conferences of the Industry, where we feel we have something to contribute to the common good. I might mention in passing that we were represented by three official delegates at the Meetings of the International Illumination Commission held in Germany in July.

We are developing a much closer contact with the work of standardization, which is carried out by the British Standards Institution. This we feel to be most important since standardization affects intimately the interests of all of us as manufacturers.

A Women's Gas Council has, as you know, been formed this year, and we have appointed two nominees to represent us officially on that body.

I want here to refer briefly to the work which is being done by the other National Bodies, since we are now in closer co-operation with them than ever before through the British Gas Federation. Their activities, which constitute another form of specialization, have a very considerable influence to-day on the work of all of us, and we are all united by a common desire to further the interests of the Industry which we serve.

Institution of Gas Engineers.

In 1929 the Institution was granted a Royal Charter of Incorporation, and as a result its basis of membership was altered, its obligations were multiplied, and the potentialities of enhancing its prestige, status, and usefulness were immeasurably increased. Research, Education, the Benevolent Fund, Meetings and Transactions are constant evidence of the activities of the Institution.

Many of those engaged on the contracting and manufacturing side of the Industry are members of the Institution, and are therefore as individuals already co-operating in its work.

The Society, in addition, is officially represented on the Advisory Committee on Research, the Joint Lighting Committee, and the Refractory Materials Joint Committee. Official co-operation of this nature has already proved of sufficient benefit to encourage me to take this opportunity of stressing the willingness of the Society to co-operate in both research and investigatory work to the fullest extent to which our co-operation is desired.

National Gas Council.

The National Gas Council was formed to meet the imperative demand for a Body, representative of both Municipal and Company Undertakings, which could voice the views of the Industry, and also both safeguard its interests and ensure its development. The National Gas Council has taken a special interest in the vital problems of legislation affecting all branches of the Industry. This work has grown to considerable proportions, involving as it does the careful scrutiny of a large number of Acts of Parliament and Statutory and other Orders. In this connection considerable benefits have been secured and Statutory rights maintained.

The Council has also been instrumental in securing the placing on the Statute Book of several Acts of Parliament for the purpose of giving greater flexibility and additional powers to the Industry. In addition to Parliamentary and Governmental work, the National Gas Council deals with general problems which confront the Industry. An example of the work which is of so much importance to the Industry is that of gas charges. A great deal of work is also undertaken for Gas Undertakings individually.

British Commercial Gas Association.

The Society contributes annually to the funds of the British Commercial Gas Association, and those members of the Society which support the Special Fund secure direct membership of the Association, and are regularly supplied with copies of the very interesting and instructive literature which the Association issues. The aim of the Association is to increase the sales of gas. It seeks to achieve this end by publicity for making better known to the public the many uses and advantages of gas, and for overcoming those lingering prejudices against its use which are founded upon ancient theories that have no relation to modern conditions. Press advertising, Press editorials, exhibitions, conferences, and lectures, dealing with enquiries from public authorities and the general public, salesmen's circles, service to individual members, these are the lines on which the Association works. The British Commercial Gas Association surely deserves our wholehearted support, and they seek it in the most practical way possible by affording us direct representation on their Committees.

Our relationships with the other national bodies have been strengthened by the formation of the British Gas Federation, and we are pursuing this policy of co-operation because we believe there is no direction open to us which offers a more fruitful field of activity in the interests of our members.

Importance of Society's Badge.

Before leaving this question of our external activities, I do want to emphasize very particularly the importance of the use of the Society's Badge. We are in no sense of the word a close corporation, but we have, as a Council, tried to confine our membership to firms of standing and repute, because we are jealous on your behalf of the good name and reputation of the Society. We want you all to feel that there is a very definite prestige value in being members, and we want you to support us by giving expression to this in the use of the Society's badge, both on your note-paper and on your advertisements. We want to secure recognition of it from our customers, as a hall-mark of quality and service.

Mr. Valon Bennett, as President of The Institution of Gas Engineers, at our Annual Dinner asked that you should, at least, give your customers the opportunity of knowing what firms were assisting the co-operative work of the Gas Industry through the British Gas Federation. As you know, if for any reason there is difficulty in using die stamped note-paper, we have very gladly accepted the suggestion of one or two interested members, and authorized the use instead of a gummed label.

So far about 35% of our members use the Badge on their note-paper, and about 15% on their advertisements. We have, therefore, still a long way to go, but it is very pleasing to know that a number of members have taken to using the Badge during the last few months.

When thinking of our internal affairs I want to refer very particularly to the question of membership, not only because new members spell more revenue, but because the more representative we are of the contractors and manufacturers, the stronger will be our capacity to help in the common councils of the Industry. I appeal particularly to firms, which clearly and by common consent should be, but are not, members of the Society, and I want the support of all of you in making this appeal. I refer to firms whose interests are wholly or very largely in the Gas Industry, and I feel I can say with every confidence that there is nothing in our activities or in the methods we adopt in the pursuit of our policy which could conceivably be held as justification for their remaining outside.

Room for Still More Members.

A large proportion of potential members are, however, probably in rather a different category, having interests both in and outside the Gas Industry, but when their interests in the Gas Industry are of any material consequence to them I feel they should join. The burden of membership of the Society is from the financial point of view in no sense of the word onerous. I want to appeal, therefore, to their feeling of public-spiritedness, to their feeling of obligation to the Industry, which in greater or less degree provides them both with their livelihood, and to the extent of their interest also with their prospects for the future, that they should join the organization which is framed to provide them with a common meeting ground and a centre from which to exert their influence and to place their ability and accumulated experience at the disposal of the Gas Industry.

I am pleased to say in passing that at this morning's meeting the Council elected seven firms to membership of the Society, making a record total of nineteen new members in the last twelve months. This number is all the more impressive when I remind you that our average number of new members joining the Society over the last ten years has been six a year.

Our present subscription cannot, as I have previously remarked, be considered onerous, but we feel we owe it to ourselves to place the Society on a stronger financial basis. Increased activity brings with it increased responsibility. We are examining the whole question carefully and thoroughly. I want, however, to make it quite clear that we are contemplating no large increase in office expenditure. Rather are we considering to what extent our desire to co-operate with our customers should be supported by

financial contributions to the projects which we undertake in common with them. We feel this must be so, and we have to consider how best to provide such finance as we may find it necessary in due course to contribute.

We believe there is a wide field of increased activity before us, and that we are in a position to make good use of our opportunities. I am well aware that it is sometimes asked what benefit is derived from membership of the Society, but I do suggest that we can only reasonably expect to derive benefit from the Society in some sort of ratio to what we put into it. I would, therefore, ask any member, who is doubtful of the value of membership, whether first of all he has taken the trouble to call at headquarters to have a talk with our Manager. Such a talk will enable him to effect an exchange of views on matters of special interest to him. A number of members have called in this way, apparently with satisfaction to themselves, and before anyone says the Society seems to be of no value to him, I do suggest he should do this.

The Council are anxious to see a much stronger feeling of *esprit de corps* among members, and surely one of the very best ways of cultivating this is by personal contact. We want to develop the Society on creative lines. Surely, therefore, we must think in terms of arousing in our members a recognition of the necessity for the Society to take a much wider view of the important problems of the Industry as a whole, and to play a much more important part in its affairs.

Surely this is not only a matter of common interest, but also a matter of self-interest.

THE CHAIRMAN'S ADDRESS

Specialization in the Gas Industry

30 Years of Progress

By D. M. Henshaw

Introduction.

The production of town's gas and of residuals resulting from the carbonization of coal had been established for three-quarters of a century before its service to the community spread to any great extent beyond that of providing light.

During the whole of this long period, although a virtual monopoly was established in the lighting field, the disposal of residuals was often an economic burden. Coke, often described as " cinders," had almost to be apologized for, and tar was often disposed of in a convenient boiler furnace or in the retort furnace.

Rapid developments and revolutionary changes are common experiences in modern industry. The introduction of a new raw material, or a new commercial product therefrom, may bring about a transformation in the habits or activities of everyday life. Without rubber the modern bicycle might never have appeared at all, and the high-speed motor car, which followed, could scarcely have been developed without its aid.

In the concluding twenty-five years of the last century the Gas Industry experienced what may be described as a series of such revolutions as a result of epoch-making discoveries by physicists and chemists. Perkins' researches had led to the establishment of the aniline dye industry, and ammonia was rapidly extending its field of usefulness in the chemical industry, as well as in its better known form as an artificial fertilizer. Other uses for derivatives of coal tar were making rapid headway; disinfectants, synthetic drugs; and pitch and carbon became important and even essential materials in the electrical industry itself.

To describe the change during this period in the lighting field as a revolution is surely no exaggeration. Auer von Welsbach's invention of the incandescent mantle following Bunsen's atmospheric burner completely changed both the cost and the standard of domestic and public lighting, and secured for gas a clear advantage as the cheapest form of artificial light over all its rivals, even electricity, for many years. During the last quarter of the 19th century, although in a spasmodic way, gas had made progress in popularity as a cooking and heating agent—again thanks to the aid of the physicist and chemist in improving our knowledge of the technique of combustion.

The process of manufacture of town's gas during this period calls for very little comment, for it cannot be said that anything revolutionary had occurred in carbonizing practice. Certainly there had been improvement in design of retort settings. The regenerative setting had made its appearance. Inclined retorts had enjoyed a period of popularity, and machine charging and discharging, and the use of conveying machinery in the handling of coal and coke, had become established.

These labour-saving devices, together with the adoption of " heavy charges " and a better knowledge of furnace design and firebrick manufacture, enabled a certain reduction in the cost of gas-making to be achieved, but the great factors which brought about a change in the fortunes of the Industry were the Bunsen burner and the incandescent mantle, and the disappearance of the need for a luminous flame, and consequently high candlepower gas. The use of cannel coals was very rapidly abandoned, and the way paved for the wider use of carburetted water gas which appeared in this country from America in the early nineties.

You may think it superfluous that, in introducing the subject, facts of history quite well known to all have been set out at some length. It was desired, however, to recall the position of the Gas Industry prior to the establishment of the Society of British Gas Industries in order to emphasize the fact that progress in improvement, in knowledge, and in practice in the Industry, apart from the results of scientific discoveries, had been slow, and that such other improvements as had taken place in the production and utilization of town's gas had been spasmodic, and largely the result of individual work on the part of engineers on the supply side, as well as the contractors. Indeed it must be admitted that the majority of the contracting engineers and appliance makers were either themselves primarily gas engineers, or their immediate successors and pupils.

During the period I have just reviewed, leaders in the Gas Industry, in common with other branches of engineering and trade generally, showed a growing tendency to specialize. It was recognized that as the demand for higher standards grew out of an accumulation of knowledge, it was almost impossible for any one engineer or any one firm to achieve eminence and success in all the manifold operations which covered the field of gas manufacture and supply. Administrators, as well as engineers and engineering contractors, made reputations as experts because of their concentration on, and special study of, one problem or branch of plant construction or appliance manufacture. Such concentration undoubtedly resulted in a speeding up of improvement in design, often resulting in a launching out on new forms of construction away from established practice.

We may see the further results of this development by continuing our review into the 20th century. Examples could be cited of specialization in almost every branch of the Industry and of great advances in economy of operation and efficiency of working which have followed. Sir Archibald Denny, the great shipbuilder, presiding at a gathering of representatives of various organizations connected with the engineering industry, including the Society, at the recent Shipbuilding and Engineering Exhibition, commented upon the great change which had taken place in prime movers since those exhibitions were first inaugurated. What, he asked, would have been the position of the electrical supply industry to-day if Parsons had not invented his steam turbine? He asked his audience to imagine the appearance and size of the interior of a power station, such as those recently built on the banks of the Thames, if reciprocating steam engines were still in use.

Progress in Gas Manufacture.

We might equally ask ourselves what would be the position of the Gas Industry to-day if its chief commodity were still sold on the basis of its illuminating quality, and without the aid of the prepayment meter? What would be the position if the modern carbonizing unit, be it horizontal or vertical, if the production of water gas, either in a separate

plant with automatic operation or in vertical retorts or chamber ovens, if waste heat boilers and the scientific production and marketing of by-products, including prepared coke, road tar, and benzole, and the distribution of gas at high pressure, had never made their appearance?

May we not say that the Gas Industry has every reason to be proud of its advancement, and that it is no whit behind other branches of engineering and industry in its achievement, even though it has had an existence as long almost as that of steam engineering itself?

The Gas Power Station.

The term " gas-works " hardly seems to be a fitting description of any one of the large gas-making units which have been built in recent years. The majority of us by reason of our occupation have acquired a familiarity with their appearance which breeds indifference, but it is doubtful if more than a very small percentage of the general public, who are only able to judge from externals, has any idea of the change which has taken place even in the last fifteen years.

Starting with the handling of the coal delivered into works—indeed, going still further back to the method of selection and the standards of analysis demanded—we can trace the concrete results of specialization. Passing through the retort house we see an ordered arrangement of labour-saving machinery, improved quality of refractory materials—in particular the adoption of silica—the conservation of heat, the reduction of escaping steam and dust, and the thought given to the comfort and health of the now comparatively small operating staff.

A marked change has taken place in the raising and utilization of steam, and in the standard of power units employed; waste heat boilers and the higher value of coke and breeze have also contributed to a great improvement in the efficiency and the appearance of such plant.

Again, a striking change has taken place in the design and construction of condensing, washing, and purifying plant and connections; the ground space occupied has been greatly reduced and reinforced concrete and welded steel construction have been freely used to secure an ordered and symmetrical design in what was previously, in most cases, an ugly conglomeration of vessels and structures of strange and wonderful form.

The same comparison might be made regarding the general appearance of works entrances, administration offices, and laboratories. The free employment of scientific instruments and automatic devices for controlling works operations and recording of results is another prominent and important feature.

Here again let us stress the fact that the best results have been achieved only by collaboration between the plant contractor and the operating engineer, building on a basis not of trial and error, but of experience, aided by the work of the physicist and the chemist.

All these things have changed almost beyond all recognition the appearance and construction of what might more appropriately be called the gas power station.

Before leaving the subject, let us emphasize once again that these things which may have become commonplace to us are not sufficiently well known to the general public, which is regularly supplied through the medium of the Press with glowing details of the wonders of the electrical super power station. The general public cannot be reminded too often that the Gas Industry is progressive in all its branches.

Public Lighting.

This brings us to the point of distribution, where we make direct contact with the general public and the gas consumer.

There was a time when gas could claim through the medium of street lighting to be in the public eye to the complete exclusion of other forms of illumination. Nor can it be said that the Industry has by any means lost sight of the strategic importance of street lighting. From the days of the ghostly arc lamps and the appearance of the incandescent mantle a constant battle has been waged, and gas has done its full share in specialized research into the best means of making streets and public places safe for the pedestrian, and the various forms of fast-moving traffic which have become a part of our modern life. Many of the best-lighted cities of this country, led by such an outstanding example as Westminster, put gas first.

It is typical of the confusion which has been occasioned by the slowly dying fashion of regarding electricity as " new " and " modern " as compared with gas, merely because it was " new " in 1870, that the public generally insists on taking it for granted that all good street lighting must be electric. It might well be obligatory on lighting authorities to have cast on all gas lamp columns the letters GAS at eye level.

Distribution System.

The next stage in our review of specialization is the distribution system. As has been pointed out by Mr. Stephen Lacey, another of the handicaps of gas resulting from long service and having been " first in the field," instead of last, is the burden of a distribution system representing a heavy capital charge, but which without adaptation would be totally inadequate to modern load conditions. The cost and practical difficulties involved in replacement of mains in congested areas is much greater than that of reconstruction on the works.

The problem has been solved by a skilful combination of boosting and governing, and the provision of feeder mains. This has reduced the cost of main laying and maintenance, and made possible the serving of outlying districts and isolated consumers at an overall capital charge, heavy though it may be, which would have been many times multiplied under the old conditions.

The difficulties of adequate distribution can be better realized when we come to consider the change which has taken place in the character of the service offered to the domestic consumer. The early pioneers in distribution and utilization would have been appalled by the complexity of the problems of meeting the demands of the present day cooking load, and maintaining satisfactory pressures to the number of points commonly served in the modern " all gas " house.

We need not enumerate here the wide range of appliances now available which render the gas-minded householder independent of solid fuel and its attendant labour and uncleanliness. Suffice it to say that here is a field in which members of the appliance and fittings sections of the Society, led, may we say, by such pioneers as the founder of the firm with which our senior Vice-President and Chairman on this occasion has been so long identified, have consistently shown the way in anticipating, rather than merely meeting, the requirements of the supply side of the Industry.

Heat on Tap.

To the appliance makers we owe in a great measure the happy position the Gas Industry has attained as the purveyor of " heat on tap." They are maintaining, and will maintain, the lead in providing new channels through which gas undertakings may increase the sales of their chief commodity. That is an all-important factor in our common prosperity, for it is recognized on every side that our future prosperity in the domestic field largely lies in the increase in sales of gas per consumer.

The Industrial Field.

We now come to a development of specialization which is recognized on all sides as having immeasurable possibilities in the future scope of town's gas. From the earliest period of the industrial era, when the works and the factory took the place of the forge and the hand worker, controlled heat has been an ideal, which latterly has grown into a necessity. The fact that in the beginning there was no economic alternative to solid fuel led to the introduction of regenerative types of furnaces and later the producer; the demand for controlled heat became still more insistent as continuous and mass production methods of heat treatment were introduced, and the advantages of town's gas, instantly available, and always consistent in quality and pressure, were recognized.

Until comparatively recently, the development of its various applications, and particularly in relation to furnace design, had been slow, but we are all familiar with what is taking place in almost every area of supply. It is obvious, of course, that opportunities in certain districts are exceptional. In the production of certain high-class commodities, such as special types of rolled steel sections, tubes, stampings, silver goods, pottery, foodstuffs, motor car parts, and manufactures in the electrical industry, the absence of dust and oxidizing atmospheres are additional advantages to those enumerated.

In 1906 The Institution of Gas Engineers established a Special Purposes Fund and set up a Gas Heating Research Committee, and a research fellowship in gaseous fuel was instituted at Leeds University. Although the industrial field could not be said to be generally recognized at that time as being of importance to the Industry, the idea of regarding gas as a fuel was steadily growing, and undertakings such as Birmingham and Sheffield, where processes demanding a continuous supply of controlled heat were in demand, began to develop a technique which soon created a load well worth cultivating.

Gas sold for industrial heating by the Birmingham Gas Department in 1910-11 represented only 5% of the total output. That has now grown to 30%, or a total of 4,000 million cu.ft. per annum. It is significant that this de-

velopment has gone hand in hand with a system of price grading to the industrial consumer. The great value of the example set by these early pioneers cannot be overestimated, nor can that of the service rendered to the nation by the Gas Industry during the War years which was thus made possible.

It is a matter for congratulation that the leaders of the national organizations, recognizing the great opportunity modern manufacturing processes offer to gas, have set up a business-like scheme for the practical application of research in this field by the creation of the Industrial Centres. We have every confidence that this movement will prove to be an outstanding and successful example of specialization and co-operation between the manufacturers and the supply side of the Industry.

It has been possible quite recently to gain first-hand information regarding the progress already made by certain of the undertakings such as Birmingham, Sheffield, Newcastle, and Stretford, which have been outstandingly active in this direction. In one case a heavy engineering works commencing with comparatively small heating operations, but appreciating the all-round improvement in speed, cleanliness, quality of work, and ease of control achieved by the use of gas in place of solid and liquid fuel, has converted furnaces to gas dealing with forgings up to 12 in. square and 4 or 5 ft. in length. Other furnaces for annealing handle charges up to 40 tons, and continuous furnaces deal with 20 tons per 8-hour shifts over periods of three days or more. The total gas consumption in this works alone is now 100 millions per year, and further conversions are expected to require a further 40 millions.

In another works already using 50 million cu.ft. per annum in forging and heat treatment shops, a further 50 millions has been obtained from shop heating, cutting and welding, and countless other operations.

In Sheffield very large furnaces have been converted, and in one instance a single furnace consumes continuously 35,000 cu.ft. per hour.

Bakeries have installed continuous biscuit ovens dealing in one case with 600 sacks of flour per week, and consuming 20 million cu.ft. of gas per annum, and in another 900 sacks of flour, using 45 million cu.ft. of gas per year and working 16 to 18 hours per day. One oven of this type, length 414 ft., the longest in Europe, deals with 1,200 lb. of flour per hour.

An electrical plant and appliance works uses 100 millions a year of coal gas, having displaced producer gas, oil, and electric furnaces. Metal melting for non-ferrous castings has been converted to gas in a countless number of works, and electric cable manufacturers have gone over from oil to gas for melting lead used for outer coatings and bitumen for insulating material.

All these facts have been stated previously in technical papers by various authors, but they deserve our special notice, particularly since just as "the cobbler's child is worst shod," perhaps we as manufacturers dependent on the prosperity of the Gas Industry are apt to lose sight of the obvious desirability of using gas wherever possible in our own works. Whether this may be the case or not, it is undeniably the duty of all members of the Society to become familiar with the work being done by the Industrial Centres in conjunction with the undertakings in whose area they are situated, and further that they should help to make known the advantages of gas as a fuel.

Administration and Control.

A review of this nature would not be complete without some reference to the effect on the progress of the Gas Industry of recent legislation, which while not perhaps removing all the restrictions imposed in earlier days, has enabled undertakings to grade and make more equitable their charges to the consumer.

While it can be said that the bulk of householders in this country are gas consumers, it is certainly also true that a very large percentage are not yet users of "heat on tap." The inducement of low price which would enable them to use gas freely both to replace solid fuel with its attendant dirt, labour, and general inconvenience, and to add to the comfort and health which gas can give by the use of the many forms of appliances which have only comparatively recently become available, would lead to a large increase in the average consumption per consumer. This is also true in regard to workshops and factories, and food producing and catering establishments of all kinds.

Some confidence may be gained from the knowledge that these developments and the problems they bring with them are not confined to this country; they are world-wide. The same trend both in the domestic and the industrial field may be observed in all European countries, and notably so in America, even in those areas where electricity is at the lowest cost figure and cheap natural gas is not available.

How far, in the absence of lower costs of production, the average price of all gas sold by an undertaking can be reduced, depends on what increase in total sales can be obtained, and again to what extent such increase can be carried without increasing overhead expenses. The severe competition of recent times has made it necessary for many of us to try out that combination for ourselves.

There is a saying of Dean Swift—"He was a bold man that first eat an oyster," and we are able fully to recognize and appreciate the enterprise and courage of those on the supply side of the Industry on whom the responsibility falls to prosecute the sales of gas under these new conditions. Moreover, we know that the co-operation between specialists on both sides is a very real thing, and we are confident, therefore, that it will bring success. Those of us who are plant builders—the heavy section—are well aware of the effect on our business which a slowing up of gas sales has on our turnover. The increase in efficiency and the consequent lowering of consumption of modern gas appliances has already had that effect in some degree, and we are, therefore, vitally concerned in the making of a united effort to secure early results in the new fields of activity. Moreover, not only should we ourselves be "gas minded" in our works, but we should see to it that our workpeople are made aware of the facts and reminded that their welfare is bound up in the wider use of gas.

In Conclusion—

In conclusion, having reviewed the progress of the Gas Industry in recent times, being ourselves aware of its present high state of efficiency, and again emphasizing the importance of the rapidly extending fields of service in industry, it can be said that at no time in its long history has gas had so great a claim to the position of a premier national industry. It is certain that no other industry is so closely and in so many ways indispensably a part of the life of the nation.

Coal is our greatest national asset, and the larger the percentage of this home produced raw material which is utilized in the public service, to provide light, heat, medical supplies, dyes and disinfectants, road material, and fuel for transport—which at the present time can only be provided by the gas and coking industries—the greater will be our national prosperity. If that is true, and it cannot be otherwise, these industries are surely deserving of every assistance and encouragement that both Government and the public can give.

I am firmly of the opinion that the time is fast approaching when these important considerations will be much more widely understood, and when public opinion will ensure that the Gas Industry takes its rightful place as the supplier of the universal fuel.

Vote of Thanks.

Mr. F. B. RICHARDS said that it was a special pleasure, as Vice-Chairman of the Council, to propose a vote of thanks to Mr. Henshaw for his Address. Mr. Henshaw was a very old friend of his, and that was why this pleasure was greater than it might ordinarily have been. The Address he had just presented was devoted to a subject close at home—namely, the Gas Industry—and in that respect it differed from some of the Addresses given in recent times by their Chairmen. The developments of the last thirty years were very profitable in that a study of them would give helpful ideas as to what they should do to ensure a maximum amount of progress in the future. The rapid and increasing rate of development and change brought it about that new methods were needed in order that they might keep abreast of the requirements of the day. The burden was thrown upon the manufacturers of plant and appliances to do their best to maintain a force of technical men—engineers, chemists, and physicists—so that the problems to be dealt with might be attacked from these different aspects. They were reaching a point when individual effort was too onerous, and this was a time when bodies like their own could step in and co-operate with bodies representative of other aspects of the Industry, so that research of this type could be carried on by collective effort in a way which would be quite impossible if individual effort alone were depended upon. It was important that the whole researches of the Industry should be pooled. The advent of the British Gas Federation had made it possible to pool the Industry's efforts to a greater extent, and he was sure they would all endeavour—their Council always bore this in mind—to participate and assist in every possible way towards that desirable end. Specialization, of course, had its difficulties; it created greater need than ever for proper direction of collective effort. There was a need for a higher type of direction to see that they aimed along the right lines and that their efforts were not dissipated. He had the greatest pleasure in proposing a vote of thanks to their Chairman for his helpful Address.

Breadth of Vision.

Mr. R. J. ROGERS, in seconding the vote of thanks, remarked that Mr. Henshaw had not taken, as some Chairmen did, the subject of his own particular work as a basis on his Address, but he had shown his breadth of vision and outlook in his review of the Industry over the past thirty years, and in the reference he had made to the features which might come before them in the near future. He knew that it was not customary to discuss or criticize a Chairman's Address, nor had he anything in mind to criticize; but he would like to refer to one phase of the Address—namely, that dealing with public lighting. They had all noticed the recent interesting announcement which was made by the Chancellor of the Exchequer in regard to proposed expenditure in connection with the improvement of the highways of the country. Most of their members would be familiar with the report recently issued by the Committee set up to enquire into the lighting of the public highways. As a society of manufacturers, he thought they would realize that the Gas Industry was likely to benefit substantially in the street lighting load if all gas undertakings, and they themselves as manufacturers, did their utmost to bring the claims of the modern types of gas lamps to the notice of the authorities. The greatest achievement would not be reached unless every gas supply undertaking in the country carried out propaganda work within its own area in order to explain and demonstrate exactly what modern gas equipment could do towards improving the lighting of the roads. The Chairman had referred to what he considered the necessity for putting the word "GAS" on the lamp columns in order to tell the public that the illuminant in that particular highway was gas. That, he thought, indicated that an enormous amount of educational work still remained to be done, and he considered that it was up to all of them, as members of this Society, whether they were directly interested in the supply of lighting equipment or not, to do their very best to point out what gas could do in this respect. They could then hope to do their share of the business which the Chancellor of the Exchequer foreshadowed in connection with highway improvement.

As one of those interested in the appliance side, he would like to say that although very great improvements had been effected in carbonization practice and the yield per ton, they as an Industry did not appear, at the present price of gas, to get as much business as they might in the way of heating appliances. In this connection he thought that he could speak for other appliance manufacturers as well as his own firm when he said that they were fully aware of their duty to continue the researches to which Mr. Richards had referred with a view to producing appliances which would give the householder greater efficiency in use together with economy; but if it was not possible with present carbonizing methods to produce gas at a price to enable it to be sold at, say, 4d. per therm, they on their side of the Industry felt they should progress in the direction of producing appliances which would consume half the quantity of gas normally used by the apparatus as well as giving greater efficiency. And they were working in that direction. They could, as a Society, claim that to whatever section they belonged they were pulling their full weight in the Industry to enable it to attain still greater heights.

A Very Live Organization.

Mr. P. SUGG remarked that he had the honour the previous day to represent the Society on the occasion of the presentation of the first report of The Institution of Gas Engineers Lighting Committee to the Autumn Research Meeting of the Institution. As representative of the S.B.G.I. he had been very well received. In fact, as their Chairman had said, the Society itself was acknowledged by the older bodies as being a very live organization. He had told them also what they were doing at their own expense in connection with research. They had research departments which were doing a great deal for the benefit of the lighting section of the Industry. He had stressed a point which Mr. Stokes, of the South Metropolitan Gas Company, had mentioned—namely, that he liked to see the gasholders down when he reached the works in the morning. He wanted to sell gas while he was asleep, and the way they could sell it was obviously by means of the lighting load. He had also told the Institution that they could rely upon the members of the Society of British Gas Industries to give them every possible assistance, not only in the laboratories but by sending experts who could give advice in connection with public lighting schemes. Public lighting represented the Gas Industry's "poster." If it were lost gas was no longer represented on the poster. Every electric light that went up was a boost for electricity, and thus people became more and more electrical-minded. But if gas could retain its public lighting then they had posters all over the country which cried "GAS" just as it had been suggested that the word should be written on each column. Many people, continued Mr. Sugg, imagined that the floodlighting of St. James's Park was by electricity because it was so extraordinarily good. It was not right that what gas did extremely well should benefit electricity. He had gone round the country recently with Major Spittle (the Lighting Superintendent of the Great Western Railway), and they had covered a number of stations. As a result of collaboration between the Railway Company, his own department, and the local gas undertakings, they had been able to retain or increase the gas lighting of many railway stations. He was certain they need not have the slightest fear at all that many miles of the proposed new road lighting would be by means of gas.

Mr. D. M. HENSHAW, in acknowledging the vote of thanks, said that when in Edinburgh recently he thought that all the floodlights in Princes Street could well have had the legend on them that they were gas lamps, and perhaps on some future occasion those responsible could bring it home to the public that this was gas lighting.

A Firm Foothold.

Mr. R. J. MILBOURNE said that there were one or two points in Mr. Henshaw's Address which he would like to touch upon. First, in regard to the question of public lighting, one did recognize that considerable difficulties had to be met; but he thought there was sufficient evidence to prove that gas now had a firm foothold, as several municipal authorities were making contracts for public lighting by gas for many years in advance. In his own town they had recently completed a contract for three years' lighting, while in some instances contracts had been signed for as many as fifteen years ahead. It was strange that while they were making every effort to retain the public lighting there was no similar enthusiasm in regard to domestic lighting, which was a very important matter. His own experience was that when their electrical friends got into a house with one or two lighting points they used it as a means for introducing their other apparatus to the consumer. Therefore he thought that they should not lose sight of the domestic lighting load; and if some of the research work to which Mr. Sugg had referred could be devoted to domestic lighting there was no reason why that load should not be retained. The point was that in many cases the lighting load was quite an important one in small towns with no industrial load.

In regard to the industrial load, continued Mr. Milbourne, that was an extremely important factor, and there were one or two cases where this load represented as much as 50% of the total output. They had to be thankful, as appliance manufacturers, that this additional load had been secured for gas, as it undoubtedly resulted in extensions of plant if it continued.

Mr. Milbourne went on to refer to administration and control and methods of selling gas. He thought they might recognize that the ordinary householder was well aware that there was such a thing as gas; the principal requirement was to extend its use by means of some attractive form of tariff. In his own Company they had instituted some five years ago a two-part tariff, and the result of that experiment had been very gratifying indeed. They found that consumers increased their use of gas entirely as a result of this tariff. It was interesting to note that a form of two-part tariff had recently been introduced in London, and he was sure that this was a step which could well be extended with a view to getting ordinary consumers to burn more gas. He would like in conclusion to add his mead of praise to Mr. Henshaw for his able Address, and he was sure that under his guidance the Society would progress with all the success it had achieved in the past.

Vote of Thanks to Mr. Clare.

Mr. E. J. FOX then proposed a vote of thanks to Mr. Clare for presiding over the meeting. They had already heard at lunch from both Mr. Henshaw and Mr. Waller of Mr. Clare's connection with the Society. He was actually their founder, and for the first few years the active Chairman. They could not help experiencing a feeling of pleasure in having him in the chair that day. He was sure the younger members of the Society could safely look upon Mr. Clare as having set them all an example not only in regard to the high standards of his business transactions but also in the principles he had always set himself to follow throughout his career. It was a matter for great gratification to feel that they had this example to follow.

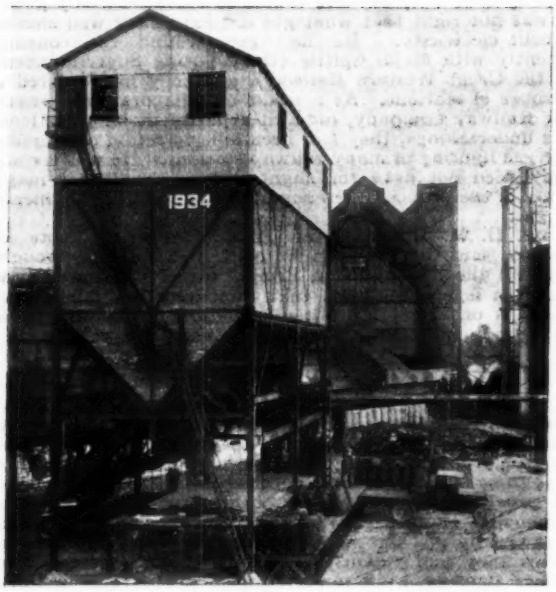
Mr. F. J. GOULD seconded the vote of thanks, remarking upon the pleasure it gave them all to have Mr. Clare with them that day. Many of them had been actively associated with him during the past thirty years, and they all held him in high esteem and great affection.

Mr. CHARLES CLARE briefly acknowledged the vote, and said that he was particularly sensitive of the honour they had done him and of the affection in which they held him.

The proceedings then terminated.

A MODERN COKE-GRADING PLANT AT Leamington

The maintenance of a steadily continuing increase in the demand for high-grade smokeless fuel can only be fostered satisfactorily by ensuring that graded gas coke of the correct size is delivered to the customer, and it was to secure this end that the Leamington Priors Gas Company decided to install the modern coke grading and bagging plant which is described in this article.



An end view of the Coke Hoppers, showing the Glover-West Vertical Retort House beyond.

When the installation of Glover-West vertical retorts was built at the Works of the Leamington Priors Gas Company in 1928, the demand for high-grade smokeless fuel was less insistent and less critical as to size than at the present time. It was a considerable advance on previous practice that the coke from the continuous vertical retort was discharged in a cool, dry condition, and that it did not require to be loaded with water for quenching purposes. A very rough screening served to separate the one or two grades, which were generally dumped straight into the carts or other vehicles of the coke dealer or coke consumer.

The object of the new plant was to produce coke sized and free from dust to meet the demand for fuel for central heating, domestic hot water, open fires, forges, and for industrial purposes, and the sizes produced for sale are identified by numbers—viz.,

No. 1 size. Screened gas coke (over 1¾ in. screen).
For steam raising and very large central heating boilers.

No. 2 size. Broken gas coke (within the limits of 1 in. to 2 in.).
For large central heating and domestic hot water boilers and coke fires.

No. 3 size. Gas coke nuts (within the limits of ½ in. to 1½ in.).
For small central heating boilers, ordinary domestic hot water boilers, and open "coal" fires.

No. 4 size. Gas coke breeze (within the limits of ⅜ in. to ¾ in.).
For small domestic hot water boilers, closed stoves, kitchen ranges, and mechanical stokers.

The utmost care is taken to ensure that the size of coke supplied to customers is that which is calculated to give the best results in the particular type of apparatus for which it is ordered, and any vagueness on the part of the customer when ordering is countered by a call by a member of the Gas Company's staff who examines the apparatus installed on the customer's premises. The customer is then advised which is the best size of coke for his purpose, and an attempt is made to educate him to "order by number." The information is also recorded and filed so that further orders from the same customer can be executed with some assurance that the correct grade of coke is being supplied.

It may be of interest to record the percentages of the various sizes of coke sold during the nine months the plant has been at work.

No. 1.	No. 2.	No. 3.	No. 4.
33%	37%	25%	5%

The dust (below ⅜ in.) from the grader and from the de-dusting screens is used on the works for steam raising.

The total coke sold locally since the plant has been at work, including that delivered by the Gas Company's own vehicles and that loaded into merchants' and customers' vehicles in the yard, is 200 tons in excess of the quantity similarly supplied during the corresponding period of 1934, and represents 64% of the total coke sold.

Coke is discharged from the retorts into a travelling chute under the retort bench which delivers it on to the bottom strand of the encircling lip-bucket conveyor. It is then elevated by the lip-bucket conveyor to a loop which runs out of the retort house over coke storage hoppers at the retort house gable. Here, previous to the erection of the new grading plant, static screens were employed for the separation of breeze, small, and large coke. When the new coke plant was installed the static screens were rearranged so that coke under 1¼ in. is delivered to the producer feed compartment, the coke over 1¼ in. being delivered to the other two compartments. With the new plant, three chutes discharge to a band conveyor which transports the coke to a cutter house.

At the grading section, the coke is graded into the five sizes: Dust, screened breeze, nuts, broken coke, and large coke.

The grader distributes the coke to the new hoppers of 11,500 cu.ft. capacity. There are two outlets from each compartment of the hoppers, one on the bag-filling side and one on the cart-filling side. Under these outlets are arranged two travelling de-dusting screens removing all dust from the coke as it flows from the hoppers.

Static Screen and Coke Cutter.

The static screen which receives the coke from the conveyor as it leaves the retort house in the first place, is of the cascade, cast-iron prong type, each prong being easily removable. This screen is for the preliminary separation or "scalping" of large coke over 1¼ in. as received from the retorts.

As the "scalping" of the coke is carried out every two hours throughout the whole day of 24 hours, it is essential to reduce noise, particularly during the night, and this type of screen is most appropriate at this point, there being no moving parts at all.

The coke cutter is of the West-Calvert type arranged to cut to 2 in. size and under, at the rate of 15 tons per hour.

The West-Calvert coke cutter is equipped with a cutting drum comprising a cast iron centre mounted upon a steel shaft, the cutters consisting of six segments attached to the centre casting in such a manner as to facilitate their replacement without taking out the centre casting or dismantling the cutter. The blades of the cutting segments are arranged in the form of spirals traversing the whole width of the cutting drum, thus reducing the driving torque of the machine (and consequent vibration) to a minimum, and allowing the machine to be started easily under load. The angle of the spirals and the shape of the blades are such that the production of breeze is reduced to a minimum. The cutting segments are of "Everlast" cast iron with a Brinell hardness No. 500.

"Everlast" cast iron of Brinell hardness No. 500, with which the side frames are also lined, is a material designed expressly to resist the abrasive action of materials such as coke.

The coke grader is of West's double deck balanced re-

ciprocating type. The outstanding feature of the West coke grader is the reduction to a minimum of mechanical parts and lubricating points, coupled with a slow speed of reciprocation resulting in a maximum durability and the minimum of noise and vibration.

The battery of new brick and steel coke-storage hoppers measures 40 ft. long by 20 ft. wide by 39 ft. high, and is divided into six equal compartments.

Travelling De-dusting Screens.

The A.C.E. de-dusting screen is mounted upon a carriage running upon rails, and can be moved as desired to any of the outlets from the coke-storage hoppers. The screen is specially designed to remove dust from coke as it flows from storage hoppers. The particular virtue of the screen is its freedom from "blinding" and clogging. Moreover, it provides rapid feed without breakage so that the comparatively small screening surface of 4 ft. 4 in. by 2 ft. will pass 18 tons per hour and maintain a high screening efficiency.

A "Belle Isle" hopper sack weighing machine receives de-dusted coke from the A.C.E. screen.

The screen and the weigher are so simple, convenient, and speedy in operation that a lorry load of coke can be weighed, bagged, and loaded in seven minutes.

[From the November issue of *West's Gas.*]

British Road Tar Association

Presidential Address of Sir David Milne-Watson

At the Eighth Annual Meeting of the British Road Tar Association, held at the Hotel Metropole, London, on Nov. 6, Sir David Milne-Watson delivered his Presidential Address, which we publish below in full.

Five-Year Road Plan.

For many months past the Road Industry, and all who are connected with it, have awaited with anxiety the developments of Five-Year Plans.

It is, therefore, gratifying to learn from the recent pronouncements of Mr. Neville Chamberlain and Mr. Hore-Belisha that £100,000,000 is to be expended by the Government over the next five years on road reconstruction. This is valuable so far as it goes, but I would remind you that £100,000,000 in five years is only at the rate of £20,000,000 per year. That there now appears to be a genuine desire on the part of the Government to release more money for roads no one will question, but the true measure of their help will only be revealed when we receive exact details of how this £20,000,000 a year is to be spent and what proportion is to be devoted to new and additional Road Works not included in the existing provisional allocations.

I have read with great interest the Minister of Transport's latest figures of expenditure from the Road Fund for the current year, but can we rightly regard his figure of 21½ million pounds—which includes amounts provisionally approved and which may not be spent for several years—as being adequate? Road transport has grown considerably again in the last few years, and the recent traffic census of the Automobile Association indicates clearly the necessity for increased expenditure on roads, for whereas in 1931 the total vehicles passing their observers was 2,600,000, in 1935 this figure had risen to 4,300,000—an increase of over 65% in five years. Can it be said that the expenditure from the Road Fund will be increased in the same proportion?

On the other hand, everyone will welcome the new system introduced by the Government of graduating the grants for the development of roads according to local financial resources, and in this connection I note that a grant of 100% is to be made for reconstructing main roads in the Highlands. While we do not necessarily cavil at this, we consider that the roads in our industrial and heavily populated areas are in much greater need of these special facilities, having regard to their individual resources and requirements.

We all realize the difficulties encountered by the Highway Authorities throughout this country in the development of their roads—their having mainly to deal with roads planned in the old "coaching" days, and with new roads which have been subject to what is popularly known as "ribbon development"—and it is for this reason I would like to offer some constructive and practical comments.

I would suggest closer co-operation between Local Authorities and the Ministry of Transport, together with adequate co-ordination between Local Authorities. France has her "routes nationales," Italy her "autostrade," and Germany her "Autobahnen," and in the reconditioning of our main roads these continental experiences should be borne in mind, to enable the main roads throughout this country to be developed in a uniform manner without changing the character of the road and its surface, which are now so prevalent and dangerous.

General progress on these lines would obviously benefit British road-making and all its allied industries—stimulate research on road and bridge building—and facilitate the development of road transport.

The latter is a matter of vital importance as the cost of transport has a large bearing on the selling price of every commodity handled to-day. Agriculture in particular would benefit, but all industries, to varying degrees, are dependent on our highways and incur considerable expenditure representing transport charges.

The ramifications and extent of Road Transport and its allied industries may be gauged from the fact that it gives employment to 1¼ million British workpeople, of whom 100,000 are directly engaged in road construction and maintenance—to that must be added a large number in indirect employment.

A further incentive to Government action in the organized development of our main arterial roads is the military and strategical aspect, as the flexibility of road transport is indeed its greatest asset in peace and particularly in emergencies and war time. We have to remember the possible danger of aerial attack in the event of a war involving these Islands, and it is vital that a fully developed road transport system, offering always the possibility of alternative routes, should be available for our national safety.

I would now like to refer to what I believe is the most important development of recent years in road planning; I refer to the passing this summer of the—

Restriction of Ribbon Development Act.

I am well aware that this Act has many shortcomings, but I think that all who take the broad view of road development will nevertheless welcome it, with all its imperfections, as a sincere attempt to put a stop to a widespread evil. In this connection, money spent on main arterial roads should not be taken advantage of by builders to reduce road charges.

I trust the Act will lead to the avoidance of all the disabilities and dangers attendant upon the lining of main roads with long rows of houses, and my only regret is that it was not in force ten years ago, but now that it is operative the dangers to the motorist and the public should be considerably reduced.

I want to make a special plea for the beautiful road—beautiful roads are a business asset of priceless value to the country, and however utilitarian our outlook may be, there can be no question that money spent on preserving roadside amenities will earn dividends for the nation.

We are constantly being reminded of the value of our

tourist industry, but I doubt whether tourists from abroad or holiday makers at home will bother very much to "See Britain First" if we do not take active steps to preserve the charm of our old roads and create beauty on our new ones.

I welcome and support the campaign jointly sponsored by the Automobile Association and the Roads Beautifying Association for more roadside reserves where motorists can pull up and enjoy the scenery. A typical reserve already exists on the North Orbital Road near Denham, in Buckinghamshire, and everyone of you will know of some other beauty spot where, given a free hand, the landscape architect could open up lovely views for the tourist without loss of amenity to the district.

It is in the interests of the public to recognize that a road should be something more than a medium for carrying traffic from town to town.

Safer Roads.

Much has been done during recent years by legislation, the energetic activities of the Minister of Transport, and various organizations to reduce the "toll of the road," but I think everyone here will agree that the present situation is far from satisfactory. With more money available for the improvement of existing roads and the consfruction of new roads, we should attempt to secure greater immunity from the congestion of our highways—so often a fruitful cause of accidents.

Here I want to say I wholeheartedly support the recent plea of H.R.H. The Prince of Wales for the construction of better and more suitably built roads for the ever-increasing number of road users, and his assertion that suitable roads mean safer roads, and that the construction of such roads is in the first rank of our National requirements.

The Ministry of Transport is experimenting and devoting much time to one of the fundamentals for reducing road accidents—namely, the provision of durable non-skid surfacing. Our efforts, also, have been continuously directed—both individually and collectively—by our own Research Workers and in collaboration with the Government's Research Workers—to the improvement of our product, and I am sure we can claim that tar is one of the—

Essentials for a Perfect Non-Skid Road.

We have proved from many practical experiments that roads safe for all types of transport in all weathers can be laid with tar as the binder—and numerous successful instances exist on main arterial roads, carrying very heavy traffic. It is interesting to note that recently on one of these roads a well-known racing motorist railed, after many endeavours, to produce a skid on either wet or dry surfaces.

Another aspect, recently given much prominence in the Press, is the disadvantage in night driving on "black roads." While tar is a "black" product, it is not necessary for tar roads to be black, as with a suitable aggregate they can easily be made light in colour.

One also sees frequent reference to cars being damaged by tar and chippings thrown off the road surface. As you are only too well aware, everything that is "black" on the roads is not necessarily tar, but in any event I would emphasize that there is no reason whatever for discomfort or waste of money if adequate care and attention are given to the proper application of the tar and chippings to the road. It is with regret, I say, that improvement in the actual application of tar for surface treatment of roads has not increased *pro rata* to the improved quality of tar itself, and there is need for greater care and attention in this direction. It is too often found that tar is unjustly made the scapegoat in cases of unsuccessful road work when in fact the real cause may be one of a number of other variables.

In this connection consideration must be given to the nature and condition of the roads to be treated and the preparation of the surface to receive the tar; the quality of tar best suited for light, medium, and heavy traffic, followed by the temperature and rate of spread at which it should be applied; also there is the nature, gauge, and rate of spread, and rolling in of the gritting material—all of which have a material bearing on the success or failure of the finished road. In other words, the effective control of these factors is necessary to success.

It is not out of place to draw attention again to the fact that tar is a—

100% British Product.

The more tar used on the roads and the less products of foreign origin, so British Industry proportionately benefits. To obtain an accurate reflection of this statement the public should realize that tar is a product of coal, and having regard to the continued distressed state of the coal industry, the need for the full utilization of all coal products should require no special commendation to Local Authorities. The great allied industries of gas, iron and steel, coke ovens, and tar distilling all benefit from the use of British tar.

A definite lead has already been given by the Government for the use of British materials on roads, and the Ministry of Transport is exercising its influence in this direction, but what is desired is a direct lead to all responsible Local Authorities to use this 100% British product of tar—which is 100% both as regards origin and manufacture. Many, of course, do so, and particulars of the excellence of the results obtained are well known to the Ministry of Transport.

We do not invite support, however, merely on patriotic grounds, but we claim for tar—

(1) That owing to its inherent qualities it builds the safest road and is therefore *the road demanded by everyone.*

(2) It builds the most economical road—both as regards initial construction and maintenance costs—and is therefore *the road demanded by ratepayers.*

The steady and unquestioned improvement in the quality of tar during recent years has curiously enough resulted at the present time in less tar being consumed. In stating that less tar is being consumed, it will be at once appreciated that this is due to the tar roads lasting longer than formerly and that re-laying or re-surfacing is only required after greater intervals of time. To counteract this reduced consumption, ample scope is available for increasing the mileage of British roads to benefit from the advantages of the application of tar.

I will now turn to matters of domestic interest. The beginning of September this year saw the termination of the five-year guarantee given by the Association to cover the two sections—one of slag and the other of granite—hot process tarmacadam laid on the Kingston By-Pass in 1930. It is very gratifying now to report that no repair has been necessary during this period. I feel I must reiterate that these are the only two sections, among the eleven laid on this by-pass, which can claim to be constructed wholly of material produced in this country. What better support could be desired than this practical test under heavy traffic to my assertion that tar is suitable for all roads!

I say "all" roads advisedly, because in the past those draining directly into fishing streams have not been entirely open to us, but the experiments we have undertaken and arrangements made in co-operation with the Ministry of Agriculture and Fisheries are on the point of completion—the Trade Mark is in course of registration, the Rules and Regulations, approved by the Ministry, are being submitted to the Registrar of Trade Marks, and the specification, with methods of testing, is now awaited from the Government Chemists. Thus, the successful termination of much research and experiment is in sight.

During the year further experimental sections of footpaths and roads have been laid at the request of the Ministry of Transport, and have to date proved satisfactory.

The first British Standards Specification for Emulsions of Road Tar and Road Tar Asphaltic Bitumen Mixtures for Penetration (Grouting and Semi-Grouting) and Surface Dressing has been published. The Specification was originally sponsored by our Association in close co-operation with the Road Emulsion and Cold Bituminous Roads Association, and it is to be hoped will result in a stimulation in the demand for our product.

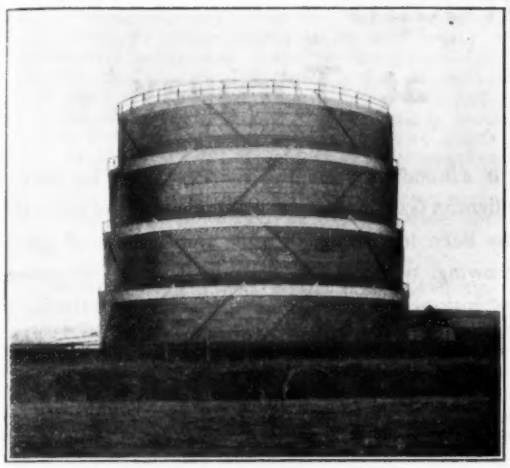
The technology of road tar is already of big dimensions and is ever being added to, and the usefulness of the International Road Tar Conference in this respect is becoming more and more apparent.

Our research work, carried out in collaboration with the Department of Scientific and Industrial Research, is progressing to an extent which, I hope, will ultimately be of benefit to all members and the public. Research work is necessarily slow, but was never more essential in all industrial activities than it is to-day.

In conclusion, I would refer to our increasing membership, and trust that the day is not now far distant when every producer and distiller of tar will be a member. An approach to 100% membership of any national and representative organization is always desirable in order that they may speak with one voice in respect of all national aspects of the Industry. It is the main objective of the British Road Tar Association that consumers of tar should be impressed with the knowledge that as an industry we are giving them a product which is the result of both our collective and individual experience, and lose no opportunity of keeping before them the merits and advantages of using British tar.

New Spirally-Guided Gasholder Inaugurated at Johnstone

In the presence of a large number of guests, a new spirally-guided gasholder, erected by Messrs. R. & J. Dempster, Ltd., of Manchester, has been formally inaugurated at Johnstone by Ex-Bailie Macpherson, Convener of the Gas Committee.



The Spiral-Guided Holder at Johnstone.

Although gas has been supplied in Johnstone since 1824 the Town Council were not responsible for its production until 1879 when they bought the Works from a Private Company.

At that time the annual make of gas was 19 million cu.ft. at a price of 5s. 5d. per 1,000 cu.ft., while for the year ended May, 1935, the make of gas was 150 million cu.ft. at a price of 2s. 4·98d. to 1s. 3d. per 1,000 cu.ft., according to consumption. The maximum daily output of gas being now in the region of 700,000 cu.ft., the question of gas storage was becoming acute, as although there were two holders of a combined capacity of 550,000 cu.ft., No. 1, which was a two-lift column-guided holder, was very badly corroded and much too light for present-day requirements.

After due consideration the Gas Committee decided to proceed with the erection of a new holder. Two schemes were considered, one the erection of a complete new holder of 500,000 cu.ft. capacity and steel tank, and the other the dismantling of the old column-guided holder and the erection of a new four-lift spirally-guided holder in an existing brick tank. The latter scheme was approved and the work of constructing this holder was undertaken by Messrs. R. & J. Dempster, Ltd., of Manchester.

The capacity of the holder is 440,000 cu.ft. and the diameter of tank is 91 ft. 10 in. Each lift is 20 ft. deep with the exception of the inner one, which has a depth of 17 ft., and the rise of the crown at the centre is 4 ft. 3 in. There are eight spiral rails on the inner lift, the others having respectively ten, ten, and fifteen. The carriages engaging with these rails are of the four roller type with grease gun lubricators.

In order to provide the additional holding down bolts, excavations were made behind the tank walls and the back bolts anchored into the brickwork afterwards being protected by concrete. The inside bolts, brick built into the tank face, are protected at the water line.

The sheets throughout are of large area—10 ft. long on the crown so as to reduce as far as possible the risk of leakage. The gasholder, when fully inflated, throws a pressure of 12 in. w.g., which will largely overcome the difficulties with which the Department had to contend on the distribution side. Upwards of one hundred and fifty thousand rivets were used in the contract.

The construction of the holder has been carried out in a most satisfactory and business-like manner, and the only real difficulty encountered was when the tank was emptied of water, a very large concrete covered dumpling was found which would only allow of two lifts being erected. This difficulty was overcome by cutting approximately 3 ft. from the outer rim of the dumpling all the way round, and erecting a concrete retaining wall so as to provide room for the third lift. The inner lift was shortened, and twenty separate rest blocks, 3 ft. in height, were fixed to support it. This work along with the provision for the new holding down bolts was entrusted to the local firm of building contractors, Messrs. J. Y. Keanie, Ltd. British materials were used throughout the contract, and as far as possible local labour has been employed in the work.

The Inauguration Ceremony and Luncheon.

Ex-Bailie Macpherson, Convener of the Gas Committee, opened the valve of the new gasholder in the presence of about eighty guests.

The guests were later entertained at lunch in the Town Hall by the Gas Committee. Councillor Muter, Convener, Edinburgh Corporation Gas Department, in proposing the toast of "The Johnstone Gas Undertaking," congratulated the Committee on their modern Undertaking. It was with pleasure he noted that the output of gas was still increasing and he saw no reason why this should be otherwise for a long time to come. He also congratulated the Gas Committee on having placed the contract for the new gasholder with Messrs. R. & J. Dempster, Ltd., as he knew they would thereby be sure of a good reliable job.

The Chairman (ex-Bailie Macpherson) in reply stated that they in Johnstone were proud of their Gas Undertaking and had every confidence in their Engineer, Mr. Alexander Jamieson, and he took this opportunity to thank Mr. Jamieson and his staff, also the staff of Messrs. R. & J. Dempster, Ltd., for the manner in which the work on the new gasholder had been carried out in face of great difficulties.

Mr. E. L. McKillop in proposing "The Contractors" said that the name of Dempster was world famous for gasworks plant and stood for good workmanship. He also mentioned that in the present contract although over 150,000 rivets had been used not one hole in a plate had to be reamered to take the rivet. Mr. J. Winson Scott (R. & J. Dempster, Ltd.) in reply said that the Johnstone holder had been a difficult proposition but they had surmounted the difficulty of the concrete dumpling in a most ingenious manner. He wished to congratulate the Engineer in the success of his arrangement. Mr. N. Y. Keanie (Messrs. J. Y. Keanie) also replied.

"Our Guests" was proposed by Mr. A. Alston Cameron, Town Clerk, and replied to by Mr. James Dickson, President of the North British Association of Gas Managers, who thanked the Gas Committee for their hospitality and said that the new gasholder was a good pointer to the prosperity of the Gas Industry.

Bailie Barr proposed the toast of "The Chairman," and ex-Bailie Macpherson suitably replied.

The Chairman proposed the "Gas Engineer," and Mr. Jamieson suitably replied.

Year's Working at Padiham

The annual report of the Padiham Gas Department during the year ended March 31, 1935, states that the gas sent out and sold during the year amounted to 127,293,000 cu.ft., being a net decrease of 4,460,000 cu.ft. The gas used for public lighting has increased by 626,944 cu.ft. to 11,275,486 cu.ft. The gas unaccounted-for had decreased by 4,051,544 cu.ft., or a decrease from 8·96% to 6·10%. The net receipts from residuals, after deducting cost of manufacture, handling, &c., was £5,678, as against £5,484 last year. The gross receipts were equal to 13s. of the cost of coal into store, as against 11s. 3d. last year. The gross receipts from coke were £61 less than the previous year, due to less tonnage of coke made and sold. The coke made for sale per ton of coal carbonized averaged 9·2 cwt. against 8·9 cwt. last year. The average price received per ton of tar has been £1 14s., against £1 16s. 8d. per ton last year. The whole of the internal gas-fitting, including the supplying and fixing of a gas cooker, gas boiler, and two gas fire points per house on the Council's Housing Scheme (70 houses) was carried out by the Gas Department. The number of meters now in use is 4,776, of which 3,135 are prepayment meters, being an increase of 51 prepayment meters and a decrease of 165 in the number of other meters. The number of cookers, boilers, and gas fires in use being the property of the Council is 1,210,280, and 108 respectively. The total revenue from the business done through the showroom and private fitting work was £3,434, compared with £3,845 last year. The revenue expenditure and income during the year were £23,559, and £30,614 respectively, leaving a gross profit of £7,055, equal to 30·1% on the Department's outstanding debt.

Fine New Gas Showrooms at Torquay

The Exterior Floodlighted at Night.

For a hundred years the service of the Torquay and Paignton Gas Company to the inhabitants of the district has been increasing. Larger annual sales of gas and growing numbers of consumers have necessitated extensions and improvements from time to time. The latest of these is the magnificent new Showrooms and Central Offices which were formally opened by Sir Francis Goodenough, C.B.E., on Nov. 6.

In the opening of the new showrooms and offices in Union Street, the Torquay and Paignton Gas Company fitly celebrates a hundred years of activity—years during which it has continued to be one of the most successful commercial enterprises in its growing area of supply.

Composed of Portland stone, decorated with glazed faience panels on the upper portion, the façade of the new premises has an air of dignity and grace. The two display windows, one on either side of the entrance, are of "invisible" glass, and a low bar of bronze, ornamented with decorative dolphins in the same material, traverses each window.

Above the ground floor the front of the building is recessed so that the first and second storeys can be floodlighted after dark by a permanent battery of six powerful gas projectors.

The premises have a total floor area of 15,000 sq.ft. and they have been constructed on the most modern lines with steel framing and reinforced concrete floors

On passing the entrance door the visitor steps immediately into the main showroom. The floor is of Travertine marble with a contrasting skirting of polished Belgian black marble. A dull pink ceiling picked out in terra-cotta and walls also of terra-cotta form a background for gas fires, cookers, and other apparatus. Individuality is given to the various exhibits, all of which are in working order, by the many handsome settings, recesses with concealed lighting being used in many cases.

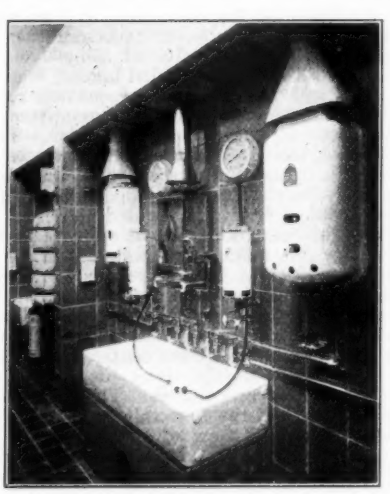
Beyond the main showrooms is an octagonal room and beyond this again the counter. A second octagonal room lies further on. Colour has been used again with effect to provide a background for the fires and lighting fittings displayed in these two rooms. In one the ceiling is of pale rose and in the other of pastel green, in each case picked out in terra-cotta.

Also on the ground floor are special rooms, one of which is a model domestic kitchen, while another is devoted to a display of gas water heaters and model bathrooms.

Demonstration Theatre.

At the rear of the building on the ground floor is the lecture and demonstration theatre. An audience of 200 can be accommodated on the tubular steel and scarlet-upholstered chairs in this spacious hall. Australian walnut panelling runs round the walls to a height of 4 ft. and a silver-grey carpet covers the floor. The raised stage at one end is concealed behind scarlet and silver curtains which part to reveal a demonstration kitchen. A recess at the back of the stage, between cupboards for supplies which are flush with the jade green walls, houses a mono metal sink, strip-lighted from above.

This hall is lighted by a decorative lay-light in the ceiling supplemented by a number of ornamental flambeaux on the walls. Some twenty-one gas lamps can be switched on in groups, while a further sixteen illuminate the stage.

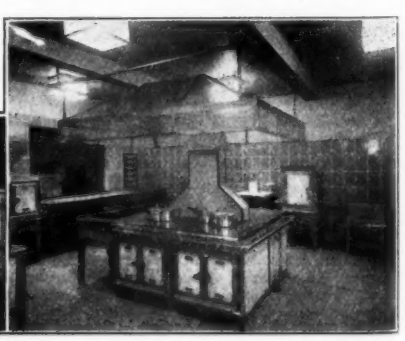


A Water Heating Display.

From the ground floor two separate flights of stairs lead to the upper floors where the Company's offices have been centralized and a third flight gives access to the basement. Travertine and Belgian black marble, Terrazzo and Portland stone have been used on the stairs and landings.

Chief among the displays in the basement is a complete model hotel kitchen and servery in working order, contain-

Further Views of the Interior of the New Torquay Showrooms.



ing the latest examples of gas-heated cooking equipment for hotel and restaurant use.

The first and second floors are given up to offices. By bringing its whole administrative staff under one roof, the Company hopes for closer co-ordination and better working. Inter-office telephones make for easier communication between the various departments and an up-to-date system of mechanical accountancy is being installed. Included in the offices is the Board Room. This is decorated in cream and mahogany and warmed by two green and silver gas fires. A system of central heating supplements the use of gas fires for the warming of the offices. Three automatically controlled gas-fired boilers serve a number of radiators and a circulatory system of hot water pipes.

Heating and Ventilation.

The general heating of the public portions of the premises is carried out on the "Plenum" system. The degree of warmth in the showrooms is automatically controlled by an air thermostat so that conditions are always comfortable. In the lecture hall the warmed fresh air is introduced through panels under the stage and the used air extracted at the back of the auditorium.

A central switchboard controls the whole of the showroom lighting, which is a wonderful revelation of what gas can do in the way of interior illumination. The floodlights on the exterior of the building, the window lights, and showroom lighting are controlled by a system of clockwork controls which automatically turn them on and off as required.

The architects were Messrs. Whinney, Son, & Austen Hall, and Messrs. Couldrey & Son, while the contractors were Messrs. P. W. Wilkins & Co.

The new showrooms were formally opened by Sir Francis Goodenough in the presence of a distinguished gathering of guests.

The ceremony itself was preceded by a luncheon at the Grand Hotel, Torquay, presided over by Major Robert P. Kitson, J.P., C.A. (Chairman of Directors). Other Directors were present, together with Mr. R. C. Taylor (Engineer and Manager), Mr. L. Easterbrook (Secretary), the Mayor of Torquay (Councillor A. L. J. d'Espiney, J.P.), and the Chairman of the Paignton Urban District Council (Councillor J. S. Huggins, J.P., C.C.).

The Toast of "Our Guests" was proposed by Major R. P. Kitson, who traced the progress and development of the Torquay Company over a century of existence. Sir Francis Goodenough responded and also proposed the Toast of "The Chairman."

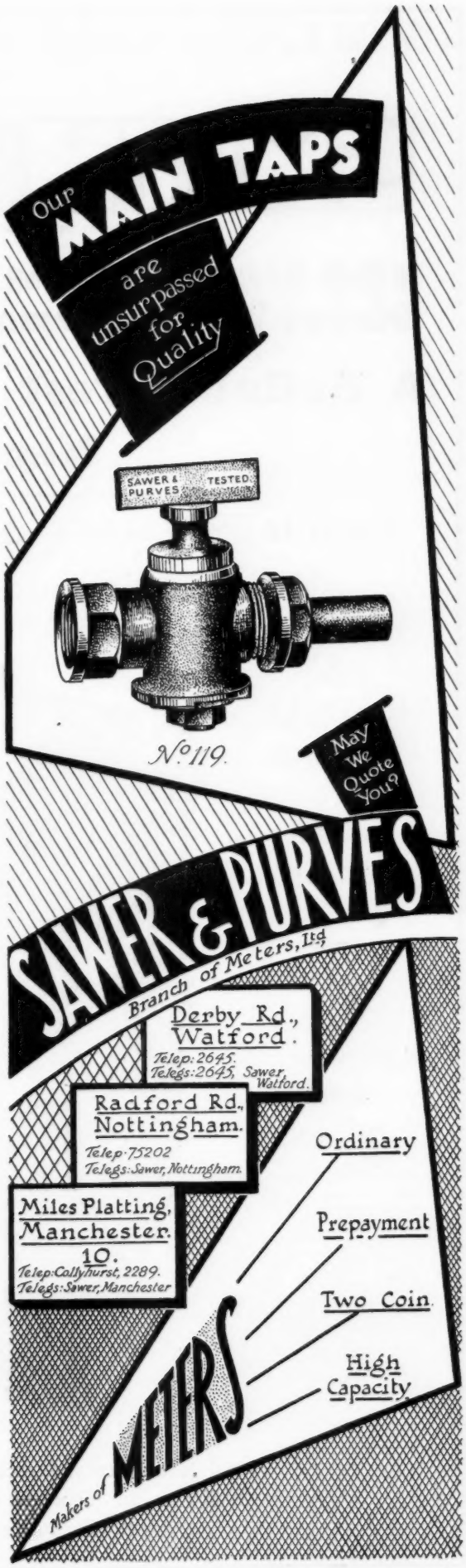
The Opening Ceremony.

Prior to the formal opening the Chairman presented Sir Francis Goodenough with a handsome silver cigar box as a memento of the occasion from the Directors of the Company.

Sir Francis, in declaring the premises open, said: To say that showrooms are the shop-windows of the Gas Industry, while very true, is in fact a considerable understatement. They are more than that. The up-to-date gas showroom is a meeting-ground for supplier and consumer where the public can see the appliances which interest it in actual working order; it is an exhibition of scientific home-planning, for it includes model kitchens, bathrooms, and so forth laid out and equipped on lines that combine labour-saving, cleanliness, convenience, and economy; and it is a "continuation school" where, with the help of skilled demonstrators of their own sex, women can not only learn how to get the best out of their labour-saving gas appliances but can add useful recipes to their cookery books. Those responsible for the planning of the showrooms I am to have the pleasure of opening to-day have, as you will see when you inspect the building, borne all these essentials in mind.

Most of our customers in the showrooms are women. In fact, every business finds that women do the shopping whoever actually pays for the goods. The result is that women have become keen critics of shopping comfort and artistic display. The standard of display and window-dressing to-day is incomparably better than that of even a few years ago. The Gas Industry cannot afford and does not mean to lag behind, for its women customers number somewhere in the neighbourhood of ten million.

There are more than a thousand gas showrooms in this country, and in the last few months many of them have been re-modelled or new premises have been erected for the purpose. As a Devon man myself, I am glad to see that many West Country gas undertakings have showrooms that are second to none in artistic planning and achievement. These new premises of the Torquay and Paignton Gas Company are a notable addition both to the architectural development of Torquay and to the services offered to its inhabitants by a public utility undertaking with well over a hundred years of history behind it, and before it a prospect of increasing usefulness.



Gas Markets and Manufactures

Stock Market Report

(For Stock and Share List, see later page)

Markets were distinctly cheerful last week and the volume of business was larger than anticipated, while under the lead of gilt-edged securities prices improved in practically all sections. A feature was the revival of interest in the Home Rail market, stimulated by favourable traffic returns, and some substantial rises in value were recorded. In view of the General Election business will doubtless ease off during the current week, though a return to greater activity is expected next week.

The Gas Market was fairly well supported, and though prices had a hardening tendency comparatively few quotations were marked up. There were no outstanding features, but it is satisfactory to note that Gas Light units and South Metropolitan ordinary continued to improve, the former rising 3d. to 27s. 9d. and the latter 3 points to 135½. At the local Exchange, Newcastle units also further advanced and closed fractionally higher at 25s. 4½d., and among debenture stocks South Metropolitan 3% rose 2½ to 87½. Apart from *ex* div. reductions the only fall of note occurred in Shrewsbury ordinary, which dropped another 5 points to 137½.

Interim dividends on ordinary shares have been announced by Associated Gas and Water Undertakings, Limited, which is distributing 2½% (payable Nov. 30), and Gas Consolidated, Limited, which is paying 2% on Dec. 2

Current Sales of Gas Products

The London Market for Tar Products.

Nov. 11.

There is but little change to report in the Tar Products market.

Pitch is somewhat firmer, and sales are reported at 35s. to 36s. per ton f.o.b.

Creosote is steady at 5¾d. per gallon.

Refined tar, 4d. per gallon in bulk at makers' works.

Pure toluole, 2s. 5d. to 2s. 6d.; pure benzole, 1s. 7d. to 1s. 8d.; 95/160 solvent naphtha, about 1s. 6d.; and 90/160 pyridine, about 4s. 9d.—all per gallon naked at makers' works.

Tar Products in the Provinces.

Nov. 11.

The average prices of gas-works products during the week were: Gas-works tar, 20s. to 25s. Pitch—East Coast, 35s. to 37s. 6d. f.o.b. West Coast—Manchester, Liverpool, Clyde, 35s. to 37s. 6d.* Toluole, naked, North, 2s. to 2s. 2d. Coal-tar crude naphtha, in bulk, North, 7¼d. to 7½d. Solvent naphtha, naked, North, 1s. 5½d. to 1s. 6d. Heavy naphtha, North, 11½d. to 1s. Creosote, *ex* works, in bulk, North, liquid and salty, 4⅝d. to 5d.; low gravity, 4¾d. to 4⅞d.; Scotland, 4¾d. to 4⅞d. Heavy oils, in bulk, North, 4¾d. to 5d. Carbolic acid, 60's, 2s. 1d. to 2s. 2d. Naphthalene, £13 to £15. Salts, 70s. to 75s. bags included. Anthracene, "A" quality, 2½d. to 3d. per minimum 40%, purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Nov.* 9.

Trading conditions are fairly brisk with values of most products tending upwards.

Crude gas-works tar.—The actual value is 26s. to 28s. per ton *ex* works in bulk.

Pitch.—Value remains unchanged at 30s. per ton f.o.b. Glasgow for export and 30s. per ton *ex* works in bulk for home trade.

Refined tar is available in large supplies at 2¼d. to 2¾d. per gallon, f.o.b. naked.

Creosote oil.—Demand is about equal to supply and prices of all grades continue steady. B.E.S.A. Specification, 5⅛d. to 5⅜d. per gallon; low gravity, 5¼d. to 5½d. per gallon; and neutral oil, 5⅛d. to 5½d. per gallon; all f.o.r. in bulk.

Cresylic acid. —There is now little available for prompt. Prices for forward delivery are firm. Pale, 97/99%, 1s. 4d. to 1s. 4¼d. per gallon; dark, 97/99%, 1s. 2d. to 1s. 2¼d. per gallon; and pale, 99/100%, 1s. 4d. to 1s. 5d. per gallon; all *ex* works naked.

Crude naphtha.—Value remains unaltered at 4¾d. to 5¼d. per gallon, f.o.r. according to quality and district.

Solvent naphtha.—90/160 grade is 1s. 3½d. to 1s. 4d. per gallon, and 90/190 heavy naphtha is nominal at 11½d. to 1s. per gallon.

Motor benzole is only available in small supplies in this district at 1s. 3½d. to 1s. 4d. per gallon in bulk at makers' works.

Pyridines.—90/160 grade is 5s. 6d. to 6s. per gallon, and 90/140 grade is 6s. to 6s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s. d.		s. d.	
Crude benzole . . .	0 9½	to	0 10	per gallon at works
Motor ,, . . .	1 3	,,	1 3½	,, ,, ,,
90% ,, . . .	1 4	,,	1 4½	,, ,, ,,
Pure ,, . . .	1 7½	,,	1 8	,, ,, ,,

Contracts Advertised To-Day

Tar.

Wallasey Corporation. [p. 554.]

Trade Notes

Change of Address.

On Nov. 30 next the Manchester office of Messrs. Worthington-Simpson, Ltd., will be transferred from Northern Assurance Buildings, Albert Square, to more commodious and important premises at 74, Corporation Street, Manchester, 4. Telephone: Blackfriars 3810. Telegrams: Condenser.

Gas Driven Compressor for Japan.

Among the contracts for steam and gas engines, condensing plant, and compressors received from various parts of the world, J. Browett Lindley (1931), Ltd., Letchworth, Herts., are at present constructing a large gas engine-driven gas compressor for the Osaka Gas Company, of Japan. The engine is rated at 340 to 370 b.h.p. and is of the four crank, four cylinder vertical type, running at 330 r.p.m. The gas compressor will have a capacity of 200,000 cu.ft. per hour to 20 lb. per sq. in. pressure. Five step fractional load control by suction valves is employed, so that the power absorbed is directly proportional to the output.

New Capital Issues

Ascot District Gas and Electricity Company.—As will be seen from our advertisement columns, Messrs. A. & W. Richards, 37, Walbrook, E.C. 4, are instructed to offer for sale by tender on behalf of the Ascot District Gas and Electricity Company £24,000 4% perpetual debenture stock at a minimum price of issue of par. Tenders must be received not later than 11 a.m. on Thursday, Nov. 21.

Overseas Opportunities

The Commercial Counsellor to H.M. Embassy at Buenos Aires reports that the Argentine State Oilfields Directorate is calling for tenders, to be presented in Buenos Aires by Nov. 28, 1935, for the supply of seamless and welded iron and steel piping of diameters ranging from ⅜ in. to 10 in. (Ref. T.Y. 5,428.)

Gas Undertakings' Results

Milnthorpe.

The 75th annual meeting of the shareholders of the Milnthorpe Gas, Coal, Coke, and Lime Company took place on Nov. 4, presided over by Mr. L. Nanson. The Directors reported a considerable increase in gas consumption, especially for heating purposes, and a good demand for appliances. There has been considerable expenditure in providing new plant and bringing the works and buildings up-to-date. A dividend of 5% was declared and a sum of £100 was transferred to the reserve fund.

Troon.

In his annual report, Mr. J. W. Beveridge, Engineer and Manager of Troon Corporation Gas Undertaking, states that the make for the year ended May 15 was 69,903,543 cu.ft., an increase of 1,507,143 cu.ft. over the previous year, the yield per ton of coal carbonized being 18,002 cu.ft., against 17,811 cu.ft. Gas sold totalled 66,134,333 cu.ft., an increase of 1,472,950 cu.ft., or 2·22%. The total income was £16,688, against £16,535, residuals and by-products realizing £1,696, as against £1,756. Expenditure under revenue account was £11,828, against £11,226, £8,424 being expended on manufacture and distribution against £8,171. A surplus balance of £4,860 is carried to the credit of the net revenue account to meet annual standing charges. Total expenditure under net revenue account is £5,815, as against £6,125. A credit balance of £278 is added to last year's carry forward of £554, giving a total balance of £832.

SMITH METERS LTD

(ESTABLISHED 1834)

186 Kennington Park Road, London S.E.11
Meter Works, Rowan Road, London S.W.16

A Reliable Test Meter is a District Necessity.

"RADIAL" VALVES GIVE CONSTANT RESULTS

A "RADIAL" Product is a sound investment.

State requirements and ask for Prices.

Dial is distinct and records in Hundredths—One—Ten—100—1,000 and 10,000 cu. ft. Screwed Cap allows easy adjustment. All meters supplied with Cocks, Flex Tubes, and Carrying Cases if required.

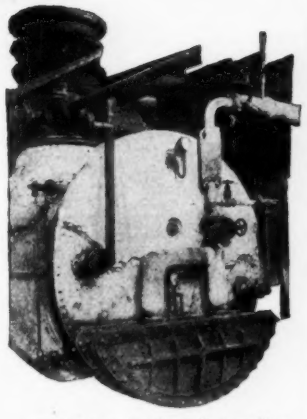
STOCK AND SHARE LIST

Official Quotations on the London and Provincial Stock Exchanges

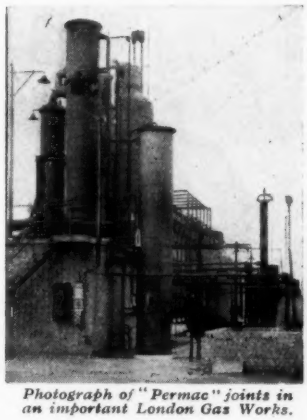
Issue. £	Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf.Yr. % p.a.	NAME.	Quotations. Nov. 8.	Rise or Fall on Week.	Transactions, Lowest and Highest Prices During the Week.
1,551,868	Stk.	Sept. 9	7	7	Alliance & Dublin Ord. ...	130—140	...	...
374,000	,,	June 24	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
557,655	,,	Aug. 12	7	7	Barnet Ord. 7 p.c.	165—170	...	...
300,000	1	Oct. 7	1/9⅝	1/4⅛	Bombay, Ltd.	1 7/16—1 9/16	...	...
178,480	Stk.	Aug. 12	9½	9½	Bournemouth sliding scale ...	222—232	...	...
550,050	,,	,,	7	7	Do. 7 p.c. max. ...	168—173	...	171—173
489,160	,,	,,	6	6	Do. 6 p.c. Pref. ...	147—152	...	...
50,000	,,	June 24	3	3	Do. 3 p.c. Deb. ...	83—88	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	105—110	...	...
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	123—128	...	125½—126
357,900	,,	Aug. 12	7½	7½	Brighton, &c., 6 p.c. Con. ...	170—175	...	173—174½
649,955	,,	,,	6½	6½	Do. 5 p.c. Con. ...	156—161	...	158
205,500	,,	,,	6	6	Do. 6 p.c. B. Pref.	142—147	...	144
1,487,500	,,	July 8	5	5	Bristol, 5 p.c. max.	120—122*a*	...	...
120,420	,,	June 7	4	4	Do. 1st 4 p.c. Deb. ...	102—104*a*	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	101—103*a*	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	127—130*a*	...	...
855,000	,,	Sept. 23	8	7	British Ord.	152—157	...	153½—155
100,000	,,	June 7	7	7	Do. 7 p.c. Pref.	155—160	...	...
350,000	,,	,,	5½	5½	Do. 5½ p.c. "B" Cum. Pref.	112—117	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	109—114	...	...
200,000	,,	,,	...	17/6§	Do. 3½ p.c. Red. Deb. ...	99—101	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1—3	...	20/-
100,000	10	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1—3	...	25/-
150,000	Stk.	June 24	4½	4½	Do. 4½ p.c. Deb. ...	83—88	...	...
626,860	,,	July 22	6	6	Cardiff Con. Ord.	127—132	...	127½
237,860	,,	June 7	5	5	Do. 5 p.c. Red. Deb.	107—112	...	...
157,150	,,	Aug. 12	6½	5	Chester 5 p.c. Ord.	109—114*b*	...	...
98,936	1	Sept. 23	2/-	2/-	Colombo, Ltd., Ord.	1⅜—1⅞	...	...
24,500	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. ...	20/—22/	...	...
609,204	1	Oct. 7	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	19/6—21/6*	...	...
296,053	1	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	24/6—26/6*	...	...
1,775,005	Stk	Aug. 12	6	5	Commercial Ord.	100—105	...	102—104
620,000	,,	June 7	3	3	Do. 3 p.c. Deb. ...	82—87	...	87
286,344	,,	Aug. 12	5	5	Do. 5 p.c. Deb. ...	121—126	...	123½
807,560	,,	Aug. 12	7	7	Croydon sliding scale... ...	151—156	...	153½
569,590	,,	,,	5	5	Do. max. div.	113—118	...	...
620,385	,,	June 24	5	5	Do. 5 p.c. Deb.	123—128	...	123½
542,270	,,	Aug. 12	10	7	Derby Con.	175—185*c*	...	...
55,000	,,	June 24	4	4	Do. 4 p.c. Deb.	100—105*c*	...	...
239,000	,,	Aug. 12	5	5	East Hull Ord. 5 p.c. ...	109—112	...	...
181,625	,,	Aug. 12	6	6	East Surrey Ord 5 p.c. ...	129—134	...	...
175,609	,,	June 7	5	5	Do. 5 p.c. Deb. ...	120—125	...	123
19,313,481	,,	Aug. 12	5⅜	5⅜	Gas Light & Coke 4 p.c. Ord.	27/3—28/3*f*	+-/3	27/6—28/3
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.	88—92	...	89—90
4,477 106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	105—108	...	106—108
8,602,497	,,	June 7	3	3	Do. 3 p.c. Con. Deb. ...	85—90	+1	87½—90
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	114—118	...	116—117
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	112—116	...	113½—114½
270,466	,,	Aug. 12	6	6	Harrogate New Cons. ...	132—137	...	...
140,000	1	Sept. 23	1/7½	1/7½	Hongkong & China, Ltd. ...	1½—1½	...	25/—25/6
213,200	Stk.	Aug. 12	6	6	Hornsey Con. 3½ p.c.... ...	130—135	...	...
5,600,000	,,	Nov. 4	14	8	Imperial Continental Cap. ...	188—198*	−4	190½—194½
223,130	,,	July 22	3½	3½	Do. 3½ p.c. Red. Debs.	92—97	...	...
285,242	,,	Aug. 12	8½	8½	Lea Bridge 5 p.c. Ord. ...	175—180	...	...
2,167,410	,,	Aug. 12	6	6	Liverpool 5 p.c. Ord.... ...	133—135*b*	−1½	...
245,500	,,	June 7	5	5	Do. 5 p.c. Red. Pref. ...	105—110*b*	...	...
306,083	,,	July 8	4	4	Do. 4 p.c. Deb.... ...	105—107*b*	...	...
165,736	,,	Aug. 26	10	8	Maidstone 5 p.c. Cap. ...	182—192	...	...
63,480	,,	June 24	3	3	Do. 3 p.c. Deb. ...	80—85	...	...
75,000	,,	May 27	†10	†10	Malta & Mediterranean ...	210—220	...	...
392,000	—	Oct. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	98—103	...	...
231,978	Stk.	Aug. 12	5	5	M. S. Utility "C" Cons. ...	108—113	...	...
818,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	100—105	...	...
360,075	,,	June 24	4	4	Do. 4 p.c. Deb. ...	102—107	...	106
148,955	,,	,,	5	5	Do. 5 p.c. Deb. ...	120—125	...	...
125,000	—	July 1	3½	3½	Do. 3½ p.c. Rd. Rg. Bds.	97—100	...	...
675,000	,,	June 24	†3	†3	Montevideo, Ltd.	48—53	...	48—50½
2,061,315	,,	Aug. 12	5½	5	Newcastle & Gateshead Con.	25/—25/9*df*	+-/1½	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	107—108*d*	...	...
776,706	,,	June 7	3½	3½	Do. 3½ p.c. Deb. ...	99½—100½*d*	...	...
277,285	,,	Oct. 21	5	5	Do. 5 p.c. Deb. '43 ...	101—103*d*	...	...
274,000	,,	Aug. 12	5	5	Newport (Mon.) 5 p.c. max....	113—118*a*	...	...
225,000	,,	Aug. 12	7½	7½	North Middlesex 6 p.c. Con.	162—172	...	...
396,160	,,	Aug. 12	5	5	Northampton 5 p.c. max. ...	105—110	...	...
300,000	,,	Nov. 4	†7	†9	Oriental, Ltd.	163—168*	−4	...
416,617	,,	June 7	8	8	Plym'th & Stonehouse 5 p.c.	162—167	...	...
504,416	,,	Aug 12	8½	8½	Portsm'th Con. Stk. 4 p.c. Std.	172—177	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	110—115	...	...
114,000	,,	July 22	5	5	Preston 5 p.c. Pref.	106—111	...	...
321,961	1	Sept. 23	...	1-	Severn Val. Gas Cor. Ld. Ord.	22/3—23/3	...	22/9—23/3
319,510	1	,,	...	-/10½	,, ,, 4½ p.c. Cum. Pref.	21/9—22/9	...	...
1,736,968	Stk.	Aug. 26	6	6	Sheffield Cons.	140—142*e*	...	...
95,000	,,	June 24	4	4	Do. 4 p.c. Deb. ...	102—104*e*	...	...
133,201	,,	Aug. 12	5	8½	Shrewsbury 5 p.c. Ord. ...	135—140	−5	135—140
90,000	10	May 27	†3	†3½	South African	3—4	...	...
1,061,779	1	Sept. 23	1/2½	1/2½	South East'n Gas Cn. Ld. Ord.	27/6—28/6	...	28/—28/4½
845,016	1	,,	-/10½	-/10½	Do. 4½ p.c. Red. Cum. Pref.	22/3—23/3	...	22/9
450,000	Stk.	Aug. 12	4	4	Do. 4 p.c. Red. Deb. ...	100—103	...	...
6,709,895	,,	Aug 12	6½	5	South Met. Ord.	134—137	+3	133—136
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf. ...	147—152	...	148
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf. ...	105—109	...	107¾—107¾
1,895,445	,,	June 24	3	3	Do. 3 p.c. Deb. ...	85—90	+2½	87—89
1,000,000	,,	July 8	5	5	Do. 5 p.c. Red. Deb....	114—117	...	...
209,820	,,	Aug. 12	8½	8½	South Shields Con.	171—173*d*	...	...
1,543,795	,,	Aug. 12	6	6	South Suburban Ord 5 p.c. ...	127—132	...	131
512,825	,,	,,	5	5	Do. 5 p.c. Pref. ...	118—123	...	120—121
500,000	,,	,,	4	4	Do. 4 p.c. Pref. ...	103—108	...	...
888,587	,,	June 7	5	5	Do. 5 p.c. Deb. ...	122—127	...	123½
250,000	,,	,,	4	4	Do. 4 p.c. Deb. ...	103—108	...	...
647,740	,,	Aug. 12	5	5	Southampt'n Ord. 5 p.c. max.	115—120	...	...
121,275	,,	June 7	4	4	Do. 4 p.c. Deb.	100—105	...	...
350,000	,,	Aug. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	112—117	...	...
200,000	,,	June 7	6½	6½	Do. 6½ p.c. Red. Deb. ...	98—103	...	...
94,000	,,	...	...	...	Do. 3½ p.c. Red. Deb. ...	97—102	...	...
1,076,490	,,	Aug. 12	6½	6½	Tottenham and District Ord.	149—154	...	150
409,835	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	130—135	...	...
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	117—122	...	117
334,615	,,	June 7	4	4	Do. 4 p.c. Deb. ...	101—106	...	...
369,774	,,	Aug. 12	7	7	Uxbridge, &c., 5 p.c.	151—156	...	...
108,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	117—122	...	...
1,340,521	,,	Aug. 12	7	7	Wandsworth Consolidated ...	157—162	...	159½—162
1,371 373	,,	,,	5	5	Do. 5 p.c. Pref. ...	118—123	...	122
1,317,964	,,	June 7	5	5	Do. 5 p.c. Deb. ...	123—128	...	127—128
338,300	,,	,,	4	4	Do. 4 p.c. Deb. ...	104—109	...	...
158,400	,,	Aug. 12	6g	5	Winchester W.& G. 5 p.c. Con.	114—119	...	...

Quotations at :—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of Stock. *g.*—Paid £3, including 10s. on account of back dividends. * Ex. div. † Paid free of income-tax. ‡ For year. § Actual for three months.

Permac
METAL-TO-METAL JOINTING MATERIAL



Front view of a Benzole Rectification Still. All joints are made with "Permac."



Photograph of "Permac" joints in an important London Gas Works.

For leak-proof Joints

In Gas Works throughout the country and on important coke-oven plant "Permac" metal-to-metal jointing material has been *proved* to withstand the most severe conditions. "Permac" holds the joint tight against the action of acids and crude oils. Use it also on less difficult joints — water and steam — and you are equally certain of success.

Permac
METAL-TO-METAL JOINTING MATERIAL.

Send for particulars to the makers :—

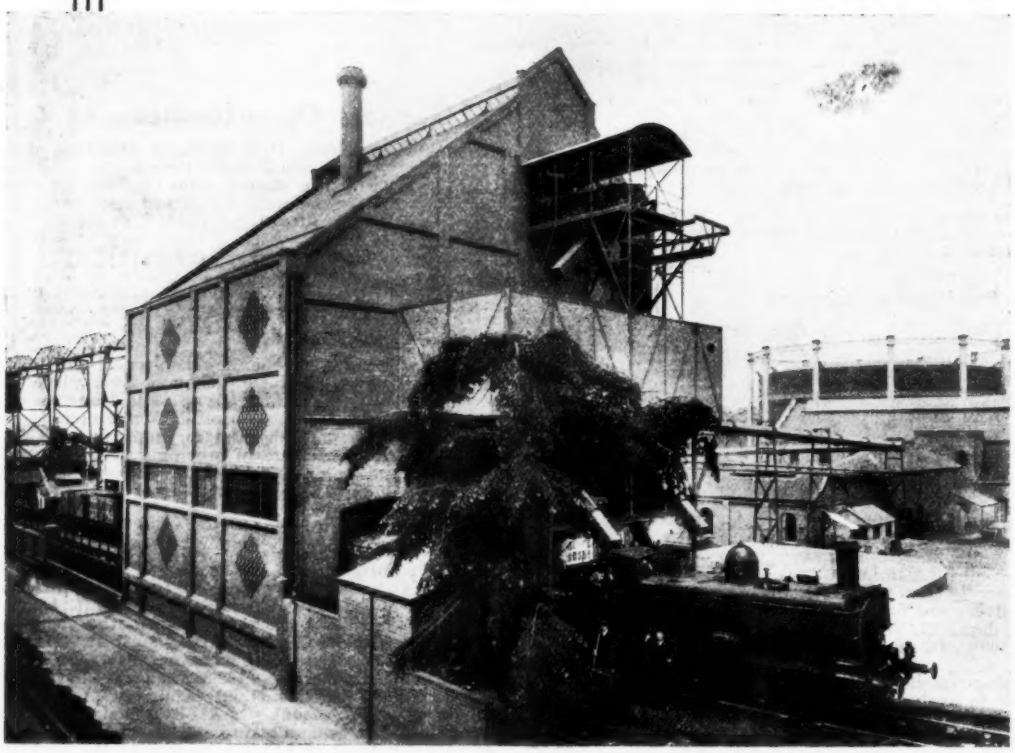
THOMAS & BISHOP LTD.
37, Tabernacle St.
LONDON, E.C. 2

The air view shows the Lowesmoor works of the Worcester New Gas Light Company. The Glover-West vertical retort installation and coke plant, seen also in the lower picture, was started up in 1934.

Modern methods to meet modern demands . . . .

THE WEST SYSTEMS

OF CARBONIZATION · FUEL-HANDLING & TREATMENT



- **CLOVER-WEST VERTICAL RETORTS**
- **WESTVERTICAL CARBONIZING CHAMBERS**
- **MECHANICAL HANDLING PLANT FOR COAL AND COKE TREATMENT & PREPARATION**

A MEMBER COMPANY OF THE

THE SOCIETY OF BRITISH GAS INDUSTRIES · 1905 ·

WEST'S GAS IMPROVEMENT COMPANY, LTD.

MANCHESTER: Albion Ironworks, Miles Platting. LONDON: Regent House, Kingsway, W.C.2

A HAPPY EVENT

THE ARRIVAL OF THE "A. & M." OPTIONAL METER AT YOUR STORES IS A MATTER FOR CONGRATULATION. IN THE MEASUREMENT OF CUBIC FEET OF GAS THIS "NEWCOMER" IS DOING WELL.

NEW BUSINESS OR REPEAT ORDERS ARE EQUALLY WELCOME, AND WE DELIVER WHERE POSSIBLE BY MOTOR WAGON.

ALDER & MACKAY LTD.

EDINBURGH, LONDON, BRADFORD & BRANCHES